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RESPONSIBILITY IN NATIONALIZED INDUSTRIES

ALTHOUGH, as Mr. Wilfred Roberts did well to remind the House of Commons in the debate on nationalized industries on March 3, the public corporation is no new feature of the social and political life of Great Britain, public concern about the efficiency and accountability of such bodies has steadily grown with the execution of the Government's programme of nationalization. The debate on March 3, which was concerned mainly with the extent to which ministers could be held responsible and questioned in Parliament concerning the activities of such bodies, followed up an earlier debate in the House of Lords on December 2 on the problems of nationalized industry. Both Mr. H. R. G. Greaves in his recent book "The Civil Service in the Changing State", and Sir John Anderson in his Romanes Lecture on "The Machinery of Government" have considered some of the fundamental problems involved in this newer type of government organisation, and there have already been published at least two critical full-length appreciations of British experience in this field—notably the study of "Public Enterprise" edited by Dr. W. A. Robson in 1937, and Mr. T. H. O'Brien's book "British Experiments in Public Ownership and Control" of the same year.

The essential problems were, in fact, well displayed fully ten years ago, but neither debate in Parliament suggests that anything like full use has been made of that experience in determining the structure of the industries already nationalized. The Lord President of the Council has on several occasions admitted the importance of proceeding cautiously and not committing ourselves to any one form or type of organisation that would hinder changes which experience might indicate as desirable. He emphasized this point particularly in an address read before the Institute of Public Administration last autumn, and, both in that address and in his reply in the House of Commons debate on March 3, he showed that he is fully aware of the importance of taking account, not merely of the questions of efficiency, accountability and responsibility, but also of ensuring enterprise and of solving the problems of economic and industrial democracy involved in the association of all classes of workers, scientific and technical as well as operatives, in the conduct of the undertaking.

None the less, Mr. Morrison rejected Capt. Crookshank's very moderate suggestion for either informal discussions between representative members of the House or for a Select Committee to investigate and report on the best way of dealing with the specific aspect of ministerial responsibility and the limits of Parliamentary questions. The distinction between administration and management was clearly grasped on all sides of the House, and it was evident that there was a general realization of the importance of the Parliamentary question, the dangers of such procedure if not used with restraint, and the vital importance of the fullest possible information being available for Parliament and the general public. Efficiency, as Mr. Bowles rightly said, would be

promoted only by Parliamentary vigilance and interest, and the essential problem is to secure the appropriate balance which will ensure the continual review of institutions and yet not hamper day-to-day management or repress initiative and enterprise.

One of the many dangers, as Mr. Molson observed, is that nationalized industry may be unwilling to move with the times or to admit that mistakes have been made; and on this point he suggested that the annual reports to be presented to Parliament should be examined by a Select Committee analogous to the Public Accounts Committee and assisted by a special permanent staff. A somewhat similar suggestion for an efficiency audit was made by Mr. Diamond; but both these constructive suggestions were dismissed by Mr. Morrison without any alternative proposal being made.

Sir John Anderson's part in the debate was limited to the elaboration of one only of the principles he had emphasized in his Romanes Lecture and earlier, before the Institute of Public Administration, as essential in determining the constitution of the authority to which a particular public task is to be entrusted and the relation of that authority to Ministers and to Parliament. Parliament, he insisted, must have adequate opportunity for inquiry, debate and public judgment; but he addressed himself more particularly to the question of the extent of ministerial control and the limits within which a Minister could be questioned in Parliament. Sir John appeared to suggest that, without interfering in day-to-day matters, a Minister should be willing to deal with questions on matters which might not strictly fall within his responsibility where the supply of information was obviously in the public interest.

The importance of that point was scarcely brought out sufficiently in either House, and Sir John himself did not refer to his own earlier comment that, where an annual report was laid before Parliament under statutory requirement, the report should be debatable. That procedure would go far, if properly implemented, to provide the opportunity for constructive criticism both inside and outside Parliament, and to ensure that there was at least an attempt to secure that, under changing conditions, public corporations could be relied upon to act with vigour, to show initiative and enterprise and to accept such risks as are normally taken by private enterprise. If we must rely on the vigilance of Parliament and the alertness of public opinion to avoid inertness, inefficiency or undue public suspicion, adequate information must be available, and whatever other means are provided, the annual report appears to be one invaluable, if not indispensable, means.

Much experience has clearly to be gained before Parliament can be satisfied that a reliable technique has been evolved, and the recent debates indicated doubts on all sides as to whether we are not being asked to move too quickly. Moreover, as Lord Lindsay pointed out, there is already a large body of common knowledge which should be used to the full both in determining the structure of nationalized industry and in its operation, and it should not be forgotten how powerful an instrument for efficiency local patriotism can be. Conversely, wise decentralization can make a vital contribution not merely to the efficiency of the nationalized industries but also to the health of local government; and doubts may well be entertained as to whether the present organisation, for example, under the Transport Commission, sufficiently meets such criticism or even those of administrative theory.

The two things that stand out most clearly are, first, the necessity for self-restraint in the attitude of Parliament to the public corporations, and secondly, the need for self-restraint on the part of the Government in extending the sphere of nationalized industry before sufficient evidence is acquired that those already nationalized are working sufficiently well to encourage further steps in that direction. The most imperative need is, in fact, that the question should be taken out of the arena of party politics and examined objectively on a scientific plane. The additional and independent scrutiny of the work of nationalized industries demands information beyond that available in published reports and accounts, and if a proper public judgment of their efficiency is to be possible the boards must come into the open. Lord Knollys, for example, suggested that the chairman and other appropriate officers should be required to appear each year before the Select Committee on Estimates and the Public Accounts Committee; but Mr. Diamond, in making his own proposal, gave as one reason the opinion that such scrutiny lies, at least in part, outside the terms of reference of these two Committees. Whatever method may be adopted, however, the boards should anticipate questions by a generous disclosure of information about their plans and activities. If Parliament is to be expected to act with restraint and confine questions to matters for which Ministers are genuinely responsible, information of other kinds must be readily accessible from the corporations. The corporations must not display the resentment which has sometimes been shown, for example, by the governing body of the British Broadcasting Corporation, as a result of requests for public information; and enough should be made known as a matter of course for their progress and difficulties to be assessed accurately and promptly by outside and impartial observers. The boards are public servants and have no need of the reticence of private business in matters of finance; but they are not Civil servants, and they have a right and a duty to answer public criticism as vigorously and as independently as it is made.

That there is room for clear thinking and impartial study of the whole question is obvious from the recent debates, and it is by no means certain that the Government yet appreciates how, until the appropriate structure has been determined, the change from private to public ownership may increase the difficulties of good technical and economic management. There can be no doubt that in time independent investigation, and possibly studies by the British Institute of Management and like bodies or by the universities, as Prof. K. C. Wheare has suggested, may throw much light on the appropriate means of

securing accountability and, equally important, public support and understanding of the work of such national boards.

What must be recognized is that, if we are, as the Lord President of the Council admitted, developing a field as yet comparatively unexplored, it is the scientific method that can be our best guide. There must be dispassionate and objective inquiry, self-restraint, and a rigorous refusal to let either sectional or private interest or party dogma interfere with the determination of the appropriate instruments by which to secure that the change from private to public ownership is marked by enterprise, initiative, and the rigorous service of efficiency and of the welfare of the nation. In particular, the question of accountability and of Parliamentary question and control must not be allowed to obscure those equally important issues, to which Dr. W. A. Robson has directed attention, namely, the necessity and extent of centralized control, the relation between size and efficiency in these nationalized undertakings and the means by which we are to measure the efficiency of a public service. Even in private enterprise, too narrow a conception of efficiency may be unsound; in public enterprise, to think of it in rigid financial, mechanical or even economic terms, may be disastrous. Yet when we leave these spheres and enter that of social accountancy, we may well find ourselves without reliable criteria or yardsticks. The devising and application of such yardsticks is one of the outstanding challenges for the student of social and economic science.

Questions of staffing cannot be entirely divorced from these questions of public responsibility, general and social efficiency and independence of pressure from sectional or private interests. Staff possessing the requisite qualities of initiative and enterprise, integrity, judgment and administrative ability will only become available when the service of the corporations is manifestly seen to encourage their exercise and to afford them ample scope as well as commensurate rewards.

INDUCTION OF TUMOURS BY CHEMICAL COMPOUNDS

Radiophysiologie expérimentale, cancer et hormones. 6: Etude de la cancérisation par les substances chimiques exogènes

Par Antoine Lacassagne. (Actualités scientifiques et industrielles, 1026.) Pp. 150. (Paris: Hermann et Cie., 1947.) n.p.

IN the preceding monograph in this series, Prof. A. Lacassagne discussed the chemistry of experimental carcinogenesis. The present work deals with the biological aspect of the subject. The pathology of chemical carcinogenesis, including the transport of carcinogenic substances in the body, the effect of carcinogens on cells, and the action of substances which modify the carcinogenic process, are discussed.

The outstanding known facts about the transport of carcinogenic substances are that they are changed chemically and excreted as derivatives in bile. The details of the chemical transformations which carcinogens undergo are still uncertain, and it is not known with certainty whether chemical change of the carcinogenic substances in the tissues is necessary for them to exert their carcinogenic action. If 1 : 2 : 5 : 6-dibenzanthracene or 3 : 4-benzpyrene is injected into animals, the greater part of the material is excreted rapidly; but a small fraction appears to remain at the site of injection for many months. The slow nature of the carcinogenic process would suggest that it is the small amount of fixed material which is the cause of the carcinogenesis. The observation of R. R. Bensley and N. C. Hoer (1934) that injected benzpyrene becomes concentrated in the mitochondria of cells is perhaps of importance in the process.

The specific changes which carcinogens are known to produce, apart from the induction of cancer and inhibition of growth, seem rather unimportant. More is known of the factors capable of modifying carcinogenesis. The process of carcinogenesis can be markedly affected by diet. Thus the carcinogenic action of tar or hydrocarbons on the skin is greater in animals maintained on diets with high fat content, and the effect of azo compounds in producing hepatomas is reduced by giving animals diets with high protein and vitamin B content. The carcinogenic action of hydrocarbons in subcutaneous tissue is influenced to some extent by the nature of the solvent used to introduce the carcinogen. These effects do not help much, as yet, in the understanding of the underlying changes of carcinogenesis. A vast amount of work carried out on the modifying action of physical agents on carcinogenesis is reviewed by Prof. Lacassagne, with the conclusion that it is difficult to say whether physical and chemical carcinogenic agents act synergistically, independently or in antagonism.

Prof. Lacassagne describes the growth-inhibitory action of carcinogenic substances discovered by Prof. A. Haddow, and discusses the antagonistic effect of weak carcinogenic compounds on potent carcinogens, which has been largely investigated in the Paris laboratories. In a typical experiment showing the antagonism, carried out by Prof. A. Lacassagne and his colleagues, one group of mice was treated with methylcholanthrene, a potent carcinogen, while a second group was similarly treated with a mixture of methylcholanthrene and a weak carcinogen, 1 : 2 : 5 : 6-dibenzfluorene. Tumours appeared later and life was prolonged in the second group, so that the weak carcinogen appeared to have an anticarcinogenic action, possibly by a blocking or competing mechanism. Even the growth-inhibiting action of 1 : 2 : 5 : 6-dibenzanthracene is reduced by addition of the feebly carcinogenic 1 : 2 : 5 : 6-dibenzacridine. This last result indicates the close correspondence which exists between growth inhibition and carcinogenesis. The action of carcinogenic hydrocarbons is neutralized by agents other than feeble carcinogens, including vesicants and substances which can combine with sulphydryl groups of amino-acids.

Theoretical chemistry has given to students of carcinogenesis a unifying hypothesis, which appears to be possibly more satisfactory than experimental work alone had been able to supply. The development of the theory by O. Schmidt, N. Swartholm and the French workers, R. Daudel, A. Pullman and B. Pullman, is described. Calculations of the distribution of free electrons in many series of polycyclic compounds indicate that there is often particularly high density of electrons about certain bonds between carbon atoms. In the polycyclic carcinogenic com-

pounds, the charge or density of electrons is above a certain limiting level, and high carcinogenic power is associated with high electron density or charge. This hypothesis, if further substantiated, should lead to better understanding of the underlying mechanism of the actions of carcinogenic substances.

Prof. Lacassagne's last chapter contains descriptions of many different substances which have produced tumours in animals. These include carbon tetrachloride, hydrochloric acid and sodium hydroxide in mice, glucose and sodium chloride in rats, and zinc chloride in cockerels. This list of odd carcinogenic agents would give the impression that carcinogenesis is not a specific property associated with definite chemical structures. Most of the work carried out in the field, however, points to definite correlation between structure and carcinogenic action, although the basis of the relationship is as yet unknown. Any comprehensive theory of carcinogenesis must also account for the action of the ionizing radiations, as well as the hundreds of known carcinogenic substances, the hormones and possibly the viruses.

In these monographs, Prof. Lacassagne has stated the main known facts of the subject and so revealed the gaps in our knowledge, and also the way to better understanding of this fascinating corner of science which is so important to mankind.

E. Boyland

DOGON PERSONALITY

Les Âmes des Dogons

Par G. Dieterlen. Pp. viii+268+15 plates. 100.70 francs.

Les Devises des Dogons

Par Solange de Ganay. Pp. viii+194+9 plates. 100.70 francs.

(Université de Paris: Travaux et mémoires de l'Institut d'Ethnologie, Tomes 40 and 41.) (Paris: Institut d'Ethnologie, 1941.)

THE social and religious institutions of the Dogon, a cliff-dwelling Negro tribe of Mendi origin who occupy the Bandiagara escarpment of the French Sudan, have formed the subject of extensive study by members of the Institute d'Ethnologie of the University of Paris under the leadership of Prof. M. Griaule. Their eight years of field-work, perhaps the most extensive and sustained yet undertaken in Negro Africa, is now beginning to bear fruit; "Jeux Dogons" and "Masques Dogons", both by Prof. Griaule, appeared in 1938; "Organisation social des Dogons" by Mme. de Paulme-Schaeffner in 1940, and these were followed in 1941 by the two monographs now reviewed, which only recently reached Great Britain.

The first, by Mme. Germaine Dieterlen, is on the Dogon conception of the soul, and is a clear and lucid exposition of a very complicated subject. A Dogon, in addition to his shadow (*kikinu bumone*), has two conceptions to which the term 'soul' could be applied: his *kikinu say*, an oversoul or true soul and a kind of super ego, and his *nyama*, a life-force or under soul, equivalent to his ego or personality. At death the *kikinu say* goes to join the ranks of immortal spirits and ultimately becomes an ancestral spirit, while the *nyama* is transmitted to his descendants. Thus the object of Dogon ancestor worship is to maintain the goodwill of the ancestral *kikinu say* and to sustain the power of his *nyama* among his descendants. For the *nyama* is not reincarnated intact in a particular descendant. A man's *nyama* is a complex affair derived from a number of different sources; part of it comes from the father who begat him, part from a particular ancestor transmitted to him while still in the womb, and part again from the clan and lineage ancestors imparted to him after birth at his naming ceremony.

The second work, by Mme. Solange de Ganay, is a study of the titular forms of address (*tige*) found among the Dogon. This custom of using special terms of address towards a person, or in many cases towards an animal or natural object, is characteristic of the Mandingo, Mossi, Joloff, Susu and other peoples of the French Colonies of Sudan and Senegal; but this is the first specialized study that has been made of it. A Dogon can be addressed by no less than twelve different kinds of *tige* indicating respectively his tribe, village, family and other social groupings, his occupation, his personal idiosyncrasies and even particular parts of his body. The particular *tige* used will show how well known he is to the speaker, and the degree of familiarity that exists between them. The author concludes that these *tige* are no mere empty titles or honourable names recording a particular or a memorable feature, but contain enduring and supernatural qualities which have been transmitted to the bearer from other individuals or groups or supernatural beings, qualities which he bears during his life-time and then transmits to his descendants. As such they are analogous to the complex of *nyama* which compose his personality. To address a person by one of his *tige* is not merely a form of politeness but also an efficacious formula for placing oneself in accord with his personality.

Of the 250 pages of Mme. Dieterlen's monograph fifty are taken up with details of the mythology connected with the foundations of the various component villages of the Dogon tribe. This could well have been relegated to an appendix or omitted altogether, as it has no bearing upon her subject. Had she given instead an outline of Dogon social or economic structure, some background against which this study of their religious beliefs could be set, she would have left the reader with a more adequate and complete impression of Dogon personality. As it is, her study, like the shorter one by Mme. de Ganay, remains an expert piece of dissection of a part of Dogon ritual and belief, but one necessitating a perusal of the three previous works for its proper appreciation.

G. I. Jones

PERSONALITY

The Cultural Background of Personality

By Prof. Ralph Linton. (International Library of Sociology and Social Reconstruction.) Pp. xii + 102. (London: Kegan Paul and Co., Ltd., 1947.) 10*s.* 6*d.* net.

THE late C. P. Scott and H. W. Nevinson were once exchanging stories which had never been printed; Nevinson complained ruefully that when he was sent to report the 'Black and Tans' in Ireland, he was shot at by both sides. Prof. Linton takes a greater risk; in his brave attempt to cross-fertilize several different studies, he may be attacked from three sides. Obviously he cannot be ignored.

During man's long effort to understand himself, there have recently arisen the disciplines of psychology,

sociology and anthropology. In Britain there are now few universities without a department of psychology, and few with departments of anthropology or sociology. So perhaps readers in Great Britain will be less touchy about threatened vested interests, but more aware of sins of omission.

Prof. Linton discusses the interrelation of the individual, society and culture, clearly, fairly, with masterly compression, in ninety-nine pages. The present reviewer wishes that reference to the work of psychologists had been less allusive, perhaps even less complimentary. But Prof. Linton writes, "most . . . of the information which we have on personality in non-European societies has been collected by anthropologists who had only a nodding acquaintance with psychology". Characteristically he includes himself in this category.

The author tackles the difficulty presented by the lack of a consistent terminology shared by all three sciences, basing his definitions upon those meanings about which there seems to be general agreement, and ignoring minority usages. As a result, he discusses very successfully the relation of the individual to culture and to society. He deprecates the practice of speaking of societies as if they have needs of their own, as distinct from those of the individuals composing them. His careful definitions of culture may build a bridge across the present gulf between psychologically minded sociologists and 'culturologists'.

There is an excellent study of personality and of attempts to find 'basic personality types' for a society. The author cites many more concrete examples than is usual in a book of this type. Its prevailing mood is enthusiasm, and its sentences are not written with the sole aim of rendering them critic-proof. The dedication is "To the students whose questions may induce their professors to read this book". The effects upon both will be excellent.

T. H. Pear

PALÆOBOTANY

An Introduction to Paleobotany

By Prof. Chester A. Arnold. (McGraw-Hill Publications in the Botanical Sciences.) Pp. xi+433. (New York and London: McGraw-Hill Book Co., Inc., 1947.) 27*s*. 6*d*.

THE author of this book is one who has made valuable additions to our knowledge of American fossil plants, especially those of the Devonian period. Here he has produced a very comprehensive treatment of the whole subject, and deals with the history of the plant world from the earliest periods in which we find evidence of the existence of plant-life down to the present day. He discusses the bearing of the evidence furnished by fossil plants on past climates, distribution of floras over the earth's surface and Wegener's theory: there is an excellent chapter on fossilization. Something more might have been added on the methods used in palæobotanical investigations, for they furnish a very clear idea of the physical nature of fossil plants. His deliberate selection of American examples makes the book of greater value to the American student than to those who are not acquainted with details of American geography and geology.

There are many illustrations which have not hitherto appeared in text-books, and for the European palæobotanist it gives an excellent idea of American palæobotanical material. The illustrations are scarcely adequate for the amount of text, or for a book which claims to be an introduction. The treatment of the groups is rather uneven: in the chapter on the ancient Lycopods there are no figures illustrating the structure of a 'cone', a Stigmarian base or a reconstruction of a complete arborescent Lycopod, although the considerable mass of evidence available would justify one. The Calamites, though less important constituents of carboniferous vegetation, have in comparison adequate illustration. In the later chapters there are twenty-one illustrations of dicotyledonous leaves, which seem more than necessary. The space utilized for two-thirds of them might have been more effectively used in the illustration of other chapters.

The book more nearly approaches a text-book than an introduction to the subject. The very large number of types, many merely introduced by name or with brief descriptions, will make the book rather heavy going for anyone who has not a fairly wide knowledge of the subject already. It is a useful addition to the library of those engaged in palæobotanical research; but it is doubtful whether a university undergraduate would find it of much assistance except for occasional reference.

John Walton

LOGICAL REALISM

A Preface to Logic

By Morris R. Cohen. Pp. xix+202. (London: George Routledge and Sons, Ltd., 1946.) 8*s*. 6*d*. net.

The Revival of Realism: Critical Studies in Contemporary Philosophy

By James Feibleman. Pp. vii+333. (Chapel Hill, N.C.: University of North Carolina Press; London: Oxford University Press, 1946.) 22*s*. net.

THESE two books both advocate logical realism, as opposed to the conceptualism or nominalism which has been fashionable in Western thought since the fourteenth century. Undoubtedly universals are concepts, but concepts are not generic images, as Prof. Cohen points out; nor are universals merely concepts if they play their parts successfully. Undoubtedly names are special kinds of universals, but to say that universals are merely names is to make knowledge illusory.

The greater part of Prof. Feibleman's book is devoted to criticism of recent thinkers. C. S. Pierce, as a realist, is approved; so is Whitehead, with reservations. Dewey, Lovejoy and Russell are dealt with more severely; especially Russell, for deserting his first love and for his prolonged, though half-hearted, flirtation with nominalism. There is an interesting section on history and the views of Toynbee. Prof. Feibleman's methods are Procrustean. If a thinker is not a proper (Aristotelian ?) realist, he is either an idealist, the exaggerated Platonic kind of realist, or a nominalist; and nominalists are either materialists or subjective idealists. This is hard on thinkers who do not fit the labels, like Kant. These, if not actually engaged in crime, are convicted of 'loitering with intent'.

Prof. Cohen's book, though smaller, carries more weight than the other, because he is constructive, never extreme, always balanced in judgment. He

discusses topics that lie on the borders of logic; the relation of form and content in assertion and inference; the nature of symbols, meaning, concepts, fictions and probability, and the logic of ethical judgments.

A reading of both books raises the old puzzle of what logic really is. Both writers repudiate the psychological interpretation. Prof. Feibleman says that logic is the general science of system or of types of order, and that pure mathematics are branches of logic. But surely the value of the mathematical sciences comes from dealing with specific types of order which are definitely of one sort and not another sort; as, for example, arithmetic deals with what has certain sorts of serial order and not with anything else. Can there be an entirely general science of order or system as such? Would it not be like that science of pure being, which, in spite of Aristotle and the Schoolmen, has never yet appeared? Aristotle's logic may be, as Prof. Feibleman says, a calculus of substance and a rather inferior business, while recent symbolic logic is a calculus of relation and far superior. Even so, they remain distinct specific sciences, and where is the generic science? Prof. Cohen in his preliminary statements says that logic is the formal element within any science, and does not appear to commit himself further. There seems to be no objection to this view, and perhaps this is all that needs to be said.

A. D. RITCHIE

RECLAMATION DISEASE IN AGRICULTURE

Koper als onmisbaar element voor plant en dier

Door W. J. Melchers en H. J. Gerritsen. Pp. 56+25 plates. (Wageningen: Gebr. Zomer en Keuning, 1944.) 1.90 fl.

"RECLAMATION disease", due to a faulty copper balance in the soil, is of considerable importance in Holland, and much research has been done on it. Melchers and Gerritsen have set out the more recent results dealing with the control of the disease, and an English summary renders the book accessible to a wider circle of readers.

Reclamation disease was originally thought to occur only on peaty-humus soils, but it is now known that it may be associated with various other types, such as pure sandy and also peat bog soils. Apparently soil containing black pitchy heather humus and/or bleached sand is the most susceptible to the disease. Early work assumed that reclamation disease was the result of definite copper deficiency; it is now realized that copper may be present in the soil but fixed in such a form as to make it difficult for the plant to absorb and utilize it.

The susceptibility of crops to reclamation disease varies with the species, cereals and leguminous plants suffering most. The symptoms vary, but usually the reproductive phase is more affected than the vegetative, though white clover offers a good example of profuse flowering and feeble leaf formation in sick plants. The chief agricultural crops are listed according to their liability to reclamation disease, with the special symptoms in each case. On grassland the botanical composition of the herbage may indicate copper deficiency, and the colour is usually strikingly dull and yellow. The better-quality grasses disappear, and the inferior varieties predominate. Cattle grazing on such grassland exhibit symptoms of disease which vary with the type of soil, and these have been proved to be associated with copper deficiency.

The degree of copper deficiency in the soil is usually determined by tests with *Aspergillus niger*, a fungus which requires minimal quantities of copper for its growth and spore formation. The only remedial measure at first used was the application of town compost; but this was limited to areas where transport costs were not prohibitive. Stable manure proved inefficient in action, but good results have been obtained by covering the deficient soils with a layer of sand about 10 cm. thick.

The application of sulphate of copper at the rate of 50–100 kgm. per hectare has proved successful in preventing reclamation disease on ploughed land. On grassland direct application is of little use, and it is necessary to plough up and cultivate the land with other crops for about two years until the lime and copper contents have been adjusted, after which grass can again be sown with more hope of success. The beneficial effect of the copper sulphate will last for several years, but for some crops, as wheat, that are more susceptible to reclamation disease, it may be necessary to give a second application sooner than with others. Finely ground slags containing a low percentage of copper produced by copper foundries are as efficient as copper sulphate, and they may be of special advantage owing to the better distribution obtained by the larger quantities necessary to supply the requisite amount of copper. Such slags are also a useful source of supply of various minor or trace elements. It may well be that continued experiments along these practical lines will do much to improve crop production in areas where reclamation disease is liable to occur.

TEMPERATURE MEASUREMENT

Methods of Measuring Temperature

By Dr. Ezer Griffiths. Third edition, revised and reset. Pp. x+223. (London: Charles Griffin and Co., Ltd., 1947.) 20*s*. net.

THE adequate control of temperature is of fundamental importance in nearly all branches of science, and there are numerous applications in industrial and technical fields. Courses of study and text-books for students of physics, chemistry, engineering and metallurgy, invariably include, in the heat section, a discussion of the methods of temperature measurement; but, in general, the treatment is too brief and inadequate. The practical difficulties inherent in all thermal measurements are very rarely appreciated, and insufficient regard is paid to the necessity of a correct choice of instrument and method for the temperature or temperature-difference measurement.

Those responsible for research or for the successful operation of industrial processes involving the precise measurement of temperature, therefore, have need of a suitable book, which, while giving a general survey of the subject, pays particular attention to the experimental basis of the methods in general use, to the accurate calibration of the instruments, and which points out clearly the errors, and the means of countering such errors, to which pyrometric observations are liable. Dr. Ezer Griffiths, who, as a principal scientific officer in the Physics Division of the National Physical Laboratory, is engaged in directing research

in this particular field, and who has himself contributed much to the advances made in the subject, is undoubtedly one of the few people well qualified to write such a book. The first edition of his book on temperature measurement appeared in 1917, was quickly exhausted and for four years was unprocurable. In 1925, the second edition, a substantial improvement on the first, was published, and now, after an interval in which the second edition also has been out of print, a completely revised and re-set version has been issued. Both earlier editions were widely accepted, a clear indication that the author succeeded admirably in his task of presenting his material in a form acceptable and useful to those engaged in industry and research.

The second and third editions, superficially, appear to be little different. The chapter and sectional divisions, including their headings, are essentially the same. The illustrations and diagrams, though slightly fewer in number in the new edition, are exactly as before, and, in spite of an interval of twelve years, only minor corrections and additions have had to be made to the numerical tables. A closer examination of the text, however, reveals that the author has made a careful revision in accordance with his own practical experience, and that of others. For example, Chapter 3, on the resistance thermometer, by omitting discussion of the Smith's difference bridge, finds space for the constructional details of the standard resistance thermometers in use at the National Physical Laboratory, and in Chapter 4, on the thermocouple, brief references to thermo-elements suitable for temperature measurements of liquid steels, in gases, and of the cylinder walls of engines, have been added.

In 1927, the International Temperature Scale was provisionally adopted, and due importance is given to this scale by the reproduction, in an appendix, of the specification finally accepted. The composition of temperature-indicating points, and a table of the agreed melting-points of the elements, form two other new appendixes.

The new edition is very well produced, and the reader will find that the larger type now used makes the book easier for reference and more pleasant to use. One minor blemish is that, although the references at the ends of the several chapters have been brought up to date and arranged in chronological order, care has not always been taken to give the complete reference, or to be consistent in the form and abbreviations used. S. WEINTROUB

METEOROLOGY FOR THE PROFESSIONAL METEOROLOGIST

Meteorology

Theoretical and Applied. By Dr. E. Wendell Hewson and Richard W. Longley. Pp. xii+468. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1944.) 4.75 dollars.

THE writers of this book have been ambitious; they have attempted, within their 450 pages, 8½ in. × 5½ in., to provide the physicist with an adequate text on all those parts of meteorology which are likely to be of concern to him in practising his profession in, say, one of the national meteorological services of the world. Whether they can be said to have been successful depends largely upon one's like or dislike of the plan they have adopted, which is to divide the subject somewhat arbitrarily into the two parts indicated by the title, and to make each part more or less self-contained, so that the 'practical' aspects of the subject can, if required, be read separately from the basic theory on which the applications depend. Thus, following an introductory chapter outlining the broad features of observations over the globe, Part 1 on theoretical meteorology comprises chapters on subjects of the expected kind (statics, thermodynamics, radiation, dynamics, etc.), but also one on the principles of meteorological statistics—a rather happy inclusion. Part 2 on applied meteorology deals with instruments and observations; the general circulation; vertical stability, air masses, weather systems and winds; fog, cloud, precipitation and aircraft icing; climatology; chart analysis and weather forecasting; and meteorology in relation to human activities. Rigour is claimed for the treatment in Part 1, to which the reader is referred for the derivation of results used in Part 2, which is more sparing of mathematics than Part 1.

Such a structure has no great appeal to the reviewer, for the content of much of Part 2 is as genuinely theoretical as Part 1, and the student coming to the subject for the first time is liable to get an unbalanced view. It is true that a more formal treatment can result in a lack of knowing 'what the subject is all about'; but that is readily avoided by bringing theory into relation with observation at every possible stage so as to provide the student with a coherent view of atmospheric processes. The writers of the book under review have certainly tackled very successfully the relation between theory or fundamental physical principles and observation in a number of cases, at the expense, however, of an irritating accumulation of cross-references and the loss of logical development in the exposition.

Aspects of the book which appeal to the reviewer are the treatment of instability; the nature, causes and occurrence of fog, cloud and precipitation (within the bounds of existing knowledge); and the application of climatological factors to an understanding of weather and its variations at particular places—one rather regrets, however, the limited definitions of the content of climatology. The rigour claimed for the treatment in Part 1 is not always evident; this is sometimes due to problems being incompletely specified, for example, the transfer of heat and matter by turbulence. There is a frequent insistence that a geostrophic wind field implies a stationary pressure field, but no mention of the fact that this derives from the neglect of the variation of the Coriolis parameter with latitude; on the other hand, there is frequent reference to vertical motion with north–south geostrophic flow—the relation of vertical motion and the equation of continuity to pressure change needs far more careful handling. Occasional looseness in definitions is also evident, as in confusing thermal conductivity with diffusivity and frequency with wave-number.

The book is, however, mainly workmanlike and within its structure attractive. If a second edition is called for, many blemishes can be removed, and the reviewer hopes that the writers will then reconsider their policy of omitting references from the text—a few are given in chapter bibliographies at present. He also hopes they will omit the existing diagram showing the high atmosphere to be composed of helium, unless, of course, some evidence accrues for this in the meantime. P. A. SHEPPARD

Mechanisms of Reactions at Carbon–Carbon Double Bonds

By Prof. Charles C. Price. (Polytechnic Institute of Brooklyn: Lectures on Progress in Chemistry.) Pp. viii+120. (New York and London: Interscience Publishers, Inc., 1946.) 15*s*.

THIS is the first of a proposed series of books by visiting lecturers to the Brooklyn Polytechnic Institute, who are reviewing progress in chemical topics. The treatment is not comprehensive, but stimulates interest by an able summary of many recent trends in olefinic chemistry. About half the book deals with the electronic theory of double-bond reactivity in ionic and free-radical processes; in the remainder these themes are developed with special reference to polymerization. Prof. Price writes from the point of view of an organic chemist; but is quick to perceive relevant physical evidence, and makes a number of interesting suggestions on problems of mechanism.

Particular prominence is given to electrostatic field effects of substituents, especially on π-electrons. Quantitative treatment is carried out by resolving electric dipole moments into bond moments and into separate charges. Rather a wide choice of sizes and arrangements of charges would appear possible, so that while the magnitudes of the effects are fittingly emphasized, the numerical results may well only be accepted with reserve. Descriptions would have been easier if there had been a greater readiness to admit into the vocabulary the term 'resonance', while the distinction drawn in places between this term and mesomerism will mean nothing to many chemists, to whom the words are synonymous.

The chapters on copolymerization and emulsion polymerization are especially interesting, and opportunely emphasize the fact, regretted by academic chemists, that publication of knowledge of these phenomena, though increasing, is still the exception rather than the rule. The apparently established use of the term 'condensation polymerization' for polycondensation is unfortunate.

More description might be given, in the text, of some of the reactions formulated; but the book is pleasantly printed. J. SHERIDAN

The Microscope

Its Theory and Applications. By J. H. Wredden. Pp. xxiv+296. (London: J. and A. Churchill, Ltd., 1947.) 21*s*.

The Intelligent Use of the Microscope

By C. W. Olliver. Pp. viii+182. (London: Chapman and Hall, Ltd., 1947.) 12*s*. 6*d*. net.

BOTH these books give a detailed account of the use and the optical theory of the microscope. It is unfortunate that so little training in the proper use of the instrument is given in biological courses, and the student often arrives at the research stage with little or no knowledge of its finer use, particularly in regard to lighting, screens, sub-stage focusing and the aperture of the objective. These books may then be welcomed as directing attention to the many optical problems affecting the critical use of the microscope. Both are well provided with illustrations, and particular attention is paid to the sub-stage optical equipment and the careful selection of a light source.

Chapters on photomicrography, light filters, and the polarizing microscope are given, and Mr. Wredden, who writes from the point of view of one who uses the microscope in the study of industrial and electrical problems, includes a chapter on micrometry. This book also contains tables of refractive indices of various substances, an index of visibility and a number of useful constants. The chapter on the preparation of specimens, although containing a number of useful hints to the beginner, is not very applicable to biological technique.

While Mr. Olliver goes into rather less detail, his book would be of great value to everyone engaged in microscopic work. At the same time, it may be observed that these instructions are of little use unless improvement is made in the condition of microscopes used by students in some biological departments, for many of these date from the early days of the century and are long past useful service.

Petrographic Micro-technique

A Practical Handbook for the Preparation of Thin Sections of Rocks for use with the Petrological Microscope. By A. V. Weatherhead. Pp. x+102. (London: Arthur Barron, Ltd., 1947.) 12*s*. 6*d*. net.

THE author of this little book has performed a notable feat, namely, to arrive within a reasonable distance of making a manual process comprehensible by means of the printed word. Nothing will compensate for lack of practice (and patience) in making thin petrographic sections, but much fruitless labour will be avoided by following in Mr. Weatherhead's steps. Perhaps the most interesting points are his experience with 'Norbide' (B_4C), as an abrasive of extreme hardness, and his use of complementary colours in controlling thickness in the course of preparation of specimens. To have achieved vertical and horizontal sections of eggshell is remarkable. If a blemish may be mentioned it is the use of the phrase "doubly polarized light". Maybe this is scarcely wrong, but it is not traditional, and is apt to mislead. "Between crossed nicols" (even if in these days we use calcite substitutes) seems preferable as a description. But this is a trifle: as a guide to micro-technique, this monograph is a first-class effort.

F. I. G. RAWLINS

Algebra

By Dr. A. Page. Pp. vii+346. (London: University of London Press, Ltd., 1947.) 18*s*. net.

THIS book is designed to meet the requirements of students preparing for examinations of the higher school certificate, intermediate and final general degrees, as well as university scholarships. It is a thoroughly sound course enhanced by many practical applications of algebra to physics, chemistry, engineering, economics and medical science. There is also, among the thirteen chapters, a valuable one on statistics. The difficulties of the subject are skilfully surmounted in an interesting way, and the book is well provided with exercises both on the text of the several chapters, and miscellaneous in the form of revision papers, to all of which answers are supplied. Only one small point calls for comment: the chapter on determinants—the last in the book—seems to come a little too late in the course. Further, it appears to contain no applications to the solution of equations, which is rather a pity, in view of the practical importance of this aspect of the subject. Nevertheless, the book may be confidently recommended as a very useful text-book for students generally, as well as for those studying for the specified examinations.

ORGANISATION AND WORK OF THE CAVENDISH LABORATORY*

By Sir LAWRENCE BRAGG, O.B.E., F.R.S.

THE Cavendish Laboratory is faced with problems which are common to most scientific laboratories in this post-war period, and arise from the great expansion in the numbers of undergraduate and graduate students. Part of this increase is a temporary phenomenon. Men are being released from the Forces who have missed the whole or part of their undergraduate time at the university, and are returning to swell the classes. The increase in the first- and second-year students at Cambridge is perhaps not as great as it is in other universities, because the undergraduate population is limited by college accommodation; in physics these classes at present are some 50 per cent greater than they were before the War. The numbers in the final honours class, however, have almost trebled, because men returning from war-work for the most part join this class, which now has about a hundred and twenty students. It will probably remain considerably higher than its pre-war level, because the recommendations of the Barlow Report reflect the need of the nation for more scientists, and demand is creating a supply. The greatest increase of all is in the number of research students, and here the Laboratory is crowded to capacity, if not overcrowded. Although all available places are used, the number of those who apply for admission as research students is three or four times as great as the number which can be accepted each year. More than a hundred and sixty researchers are now working in the Laboratory, of whom 110 are research students working for their Ph.D. degrees —between one-fifth and one-sixth of the total number registered for research degrees in Cambridge.

This large increase implies a major change in the organisation of the Laboratory. The old days when the head of the department could be in close contact with all his research students are a matter of the past. There would appear to be a limit in organisations of all kinds to the number of men whom any one head can direct by close personal contact, this number being about six. It applies in the direction of research as well, and devolving of responsibility is essential when numbers rise above this limit. Even before the War, numbers of researchers in the larger laboratories were approaching the 6^2 level, and now they are in the 6^3 region. In other words, the organisation of the research work involves splitting up the men into large groups under leaders, and these again into smaller groups, so that the head of the department is two removes from the researcher himself. Except in a few special cases of work in which he is particularly interested, he cannot afford to spend that two- or three-hour period every fortnight or so talking over his work with the individual, which is essential for real direction.

The major groups in the Cavendish Laboratory are nuclear, radio and low-temperature physics, crystallography, metal physics and mathematical physics, with some minor groupings. It may be interesting to give some account of the extent to which these groups are independent, and of the common ground on which they meet. The great foe of research is administrative responsibility. A nice adjustment has to be made between giving the heads of groups as much freedom as possible to make their plans for using their facilities to the best advantage, and at the same time relieving them of the more tiresome and mechanical details of administration which can be properly centralized. In our organisation each group has its own allocation of the budget for the year, and its own order-book, so that apparatus and supplies can be bought within that budget; each has its own staff of assistants and its workshop; it has its own secretary for clerical work; further, each group runs its own colloquium, where scientific papers from other laboratories are discussed and the researchers give reports of their progress. The days are past when most researches in a department were on closely related lines and a joint colloquium was possible. A colloquium in one group or another is now an almost daily event, and no individual can spare the time to go to them all. Common touch is kept up by the fortnightly meetings of the Cavendish Physical Society, where the heads of the groups give an account of the work going on in their sections, and distinguished visitors speak, and by more informal meetings of the leading researchers, such as the little club which was founded by Kapitza when he was head of the Mond Laboratory.

The administrative burden of the teaching staff has been much lightened by the appointment by the University of a secretary to the Laboratory. This officer has in his charge finance, appointments of assistant staff and rates of pay, the formal work concerned with admissions, structural alterations and upkeep of the buildings, preparation of agenda for meetings, and other matters of this kind.

A main workshop serves all sections of the Laboratory, where work requiring special tools and skills is carried out; glass-blowing is also centralized. There is also a separate central workshop where research students can use the machine tools, where the young assistants are trained, and where repairs to class-apparatus are carried out. In addition, two special centres deserve mention. It has been found convenient to have a 'special techniques' workshop where the most highly skilled and delicate work of especial kinds is carried out, and to place this workshop in charge of a member of the staff. It is largely concerned with the construction and sealing of Geiger counters, and the purification of the gases with which they are filled. Special thermionic devices are made there, and evacuated, baked and sealed. It manufactures delicate metal parts by a photographic technique, such as supports for thin-walled windows, makes special metal-to-glass or metal-to-silica joints, and has apparatus for preparing thin metal films by evaporation. The other centre, also in charge of a member of the staff, constructs and maintains electronic equipment of all kinds, such as decimal scalars and multiple coincidence circuits, or pulse and D.C. amplifiers for nuclear work. The capital value of the electronic equipment of this kind approaches five figures, and it is a saving of time and money to place it in charge of an expert.

The largest group in the Laboratory is the nuclear physics group, under Prof. O. R. Frisch and Mr. E. S. Shire, with some forty researchers. The Cambridge equipment includes the one-million and two-million volt sets in the high-tension laboratory, and a cyclotron with 37-in. pole-pieces. A five-million volt Van de Graaff generator is being built for the Laboratory by the English Electric Company, and it is hoped to get it running by the end of 1948.

* From a course of three lectures at the Royal Institution on March 4, 11 and 18.

The maintenance of these large and complex units introduces problems of a new scale in a physics laboratory. It creates the need for a new type of staff member, the 'technical officer'. He must be a trained physicist, in general a university graduate, but a man who has the engineer's outlook and who is interested in the construction and functioning of the apparatus rather than in the research which is done with it.

The radio group represents the continuation in the Laboratory of the work which Sir Edward Appleton started when he occupied the Jacksonian chair at Cambridge; it is now under the direction of Mr. J. A. Ratcliffe. It has field stations as well as its section of the main Laboratory. The work on propagation is mainly concerned with the longer wave-lengths which are reflected below the *E*-layer. Another section is making measurements of the waves in the metre wave-length region coming from the sun, recording their intensity and propagation and estimating the size of the source from which they come by a method analogous to Michelson's method of measuring the angular diameter of a star.

The Mond Laboratory is now under the direction of Dr. D. Shoenberg, its former head, Dr. J. F. Allen, having been recently appointed to St. Andrews. A main interest is the properties of superconductors, in particular the penetration of magnetic fields into superconductors. It has equipment for the magnetic method of cooling. Liquid helium is at present made by Kapitza's expansion machine; but a new machine of greater capacity and more orthodox type is under construction.

In crystallography, under Dr. W. H. Taylor, the arrangement of atoms in minerals, alloys, organic compounds and proteins is being studied. The section studying proteins under Dr. M. F. Perutz and J. C. Kendrew has this year been accorded the backing of the Medical Research Council. The elucidation of the structure of such enormous and complex molecules is the most ambitious problem as yet tackled by X-ray analysis, and success would cast a flood of light on the structure of living matter.

The metal physics section, under Dr. E. Orowan, is concerned with problems of slip and plasticity, fracture, crystal growth, and metallic phenomena in general investigated by physical methods.

The Laboratory houses an electron microscope service which is used by all departments of the University. It provides hospitality for several researchers from other departments. Particularly welcome guests are the mathematical physicists, including the Plummer professor, D. R. Hartree, who have rooms in the Laboratory.

It may be of interest to assess in round figures the cost of research in the Cavendish Laboratory. The figures must be approximate, since many of the services are common to teaching and research. As an example, in the following estimate the time of the University staff is regarded as divided equally between teaching and research, and its cost apportioned accordingly. Making similar adjustments for administration, assistant staff, stores and apparatus (almost entirely research) and so forth, the total expenditure on research in the Laboratory (including the Mond) was just short of £60,000 in 1946–47, of which £10,000 came from outside sources. To this must be added a sum to represent the rental of the buildings, which does not appear in the estimates. In estimating the cost per research student, the abnormal position of nuclear research must be taken into account. Not only are the running expenses above the average, but also units such as the cyclotron represent a large outlay of capital, and special grants are made by the Department of Scientific and Industrial Research to meet needs which the University cannot finance from its own resources. Such requirements vary very greatly from year to year, and I have therefore only included a sum for nuclear research which corresponds to the expenditure per researcher in other branches of physics, and which roughly represents the contribution which the University itself makes towards the cost of the nuclear research. On this basis, the cost per research student is £400 a year. If to this is added £350 to represent the average maintenance grant of junior and senior workers, the total cost to the State of maintaining a research worker in the Cavendish Laboratory is £750 a year.

MAN'S ORGANS OF SPEECH

THE Huxley Memorial Lecture for 1947, under the auspices of the Royal Anthropological Institute, was delivered by Dr. W. L. H. Duckworth, reader emeritus in human anatomy in the University of Cambridge. The subject was "Some Complexities of Human Structure"*. The approach was frankly anatomical and was a meticulous and masterful analysis of the facts, anatomical and racial, relating to the organs of speech in man. Duckworth wasted no time on the classical definitions of anthropology; he ignored the subdivisions of the subject and refused to be drawn into the finer distinctions of zoological anthropology, physical anthropology, social and cultural anthropology and ethnology. He kept clear of the pathological and avoided the theories of aphasia from Broca and Bastian to Henry Head. Here was the approach to the anatomical aspect as emphasized by Galen in his "Methodus Medendi": "The magnitude of a disease is in proportion to its deviation from the healthy state; and the extent of the deviation can be ascertained by him only who is perfectly acquainted with the healthy state". Hence the justification for the intensive study of normal structure and function in man as distinct from booksellers' notes about positive health and social medicine.

Duckworth dealt in turn with our present knowledge of the anatomy of the organs of speech, from lips, tongue, jaw, palate to the component parts of the larynx and finally the brain. To listen to so distinguished an anatomist, who is also the doyen of physical anthropologists, survey the field, much of his own ploughing and harrowing, was an intellectual feast. Rarely has a lecturer given facts and their history, as T. H. Huxley demanded, and yet exposed the gaps in our knowledge in both anatomy and physical anthropology. His survey of the work to be done provided bone and grist for many young workers. Here surely was God's plenty for the young anatomist in the laboratory and the young anthropologist in the field. The survey from Cuvier's postulate that articulate speech was the distinctive character of man to the vast modern demands of phonetics, linguistics and psychology was a criticism and yet a stimulus to the biological study of the organs of speech, emphasis being laid on the need for perfect acquaintance with the healthy normal anatomical structure.

* Some Complexities of Human Structure. By Dr. W. L. H. Duckworth. (Huxley Memorial Lecture for 1947.) Pp. 12. (London: Royal Anthropological Institute, 1947.) 3*s.* 6*d.*

The description of the racial variation in the muscles of the lips in Australian, Negro, Chinese and White paid due credit to the careful dissections and theories of Huber in the United States and Lightoller in Australia. The gradual change from the coarsely bundled muscles of the bulky lip of the one to the finely bundled and more differentiated muscles of the smaller lip of the White was analysed both in terms of facial expression and speech. Duckworth insisted that the variety of movements accompanying the variety of structure are skilled, and saw no reason why they might not become more skilled in the future. It is interesting to note that this work of Lightoller's, ignored by most anatomists, was seized upon by Dr. E. W. Fish[1] to modify the technique of fitting artificial teeth in the aged. Fish expanded the dentures laterally so that their position was maintained by the modiolus or hub formed by the converging muscles lateral to the angle of the mouth. The utilitarian aspects of transcendental research are ever present, whether it be the grouping of relatively minute and insignificant muscles in the face or the Hertzian waves.

That strange amateur anatomist, F. O. Ward[2], in the middle of last century described the hyoid bone as "the only instance in the human body of a strictly solitary bone . . . supported in its position by the muscles and ligaments to which it gives insertion". The embryologist, immersed solely in the intricacies of the second and third branchial cartilages which contribute to the formation of the hyoid bone, has studied the early development of this bone. The possibility of changes in the structure of the hyoid bone with age, sex and vocal disability ranging from stammering to dumbness still awaits investigation. So far back as 1866, Huxley[3] described the larynx in his famous "Lessons in Elementary Physiology" as "perhaps the most singular motor apparatus in the body". Yet, in spite of Edison's invention of the phonograph in 1877, and the spread of the gramophone and wireless broadcasting in the twentieth century, the larynx has been but little studied by the modern anatomist and physiologist. As Duckworth pointed out, the outstanding contribution of recent years has been the "Mechanism of the Larynx" by Negus[7], a book "absolutely indispensable for every physical anthropologist, and for the purpose of any research in laryngology, whether normal or pathological".

In 1833 a French surgeon, Cavasse[4], pointed out that fracture of the thyroid cartilage, a result of garrotting, never takes place in the mid-line, because the two lateral parts of the cartilage unite by the intervention of a median cartilage, perfectly conscribed, which Rambaud and Regnault[5] called the vocal cartilage. It is visible by transillumination especially in young subjects, and gives attachment to the vocal cords. It is ossified from a separate centre, contains more elastic tissue in the young than the two lateral laminæ of the thyroid cartilage and affects the production of the voice. Yet Quain[6] in 1914 was content with the statement that "in the infant the isthmus of the thyroid cartilage differs from the two laminæ in being less opaque and more flexible". All other anatomical text-books have been dumb on this complexity of human structure, particularly the more recent ones.

In the second century A.D., Galen gave a detailed description of the larynx, and for eighteen centuries the eponym 'nerve of Galen' has been employed for the constant anastomotic branch between the superior and inferior laryngeal nerves. Moreover, Galen first reported the experimental proof of the function of the recurrent laryngeal nerve of the vagus by tying or dividing the nerve and thus weakening or destroying the voice of the animal. Surely, as Benjamin Franklin said, "all our knowledge . . . has been obtained by fragments, and our future acquisitions must be made in the same manner".

This brief and inadequate description of Dr. Duckworth's Huxley Lecture provokes the remark that editorial articles in *Nature* discussing the functions of universities have failed to mention one, namely, to provide for a green old age for scholars and men of science. Little note has been taken that such provision requires an atmosphere devoted to the maintenance of mental activity, cheerful disposition, simplicity of living on one hand, and absence of business urge, desire for wealth, and all tawdry ambitions of worldly importance on the other. At a time when the universities are in danger of being monopolized by the search for smaller atoms, bigger bombs, and diabolical and destructive enzyme poisons, it is well to re-echo Montaigne's last prayer "to know how to enjoy with loyalty our life". As Tocqueville and Lecky tried to make clear, this may be the very basis of anthropology.

H. A. Harris

[1] Fish, E. W., "Principles of Full Denture Prosthesis" (London, 1933).
[2] Ward, F. O., "Outlines of Human Osteology" (London, 1838).
[3] Huxley, T. H., "Lessons in Elementary Physiology" (London, 1866).
[4] Cavasse, "Thèse sur les fractures traumatique du larynx" (Paris, 1833).
[5] Rambaud, A., et Regnault, Ch., "Origine et développement des Os" (Paris, 1861).
[6] Quain, "Elements of Anatomy". 11th Edit., 2, Pt. 2 (London, 1914).
[7] Negus, V. E., "The Mechanism of the Larynx" (London, 1929).

INTERACTION OF WATER AND POROUS MATERIALS

A GENERAL Discussion of the Faraday Society on "The Interaction of Water and Porous Materials" was held at University College, Southampton, during March 31–April 2. The four groups of papers on the programme were concerned with (*a*) fundamental, (*b*) botanical, (*c*) zoological, mainly entomological, and (*d*) industrial aspects of the penetration and movement of water in porous materials. They were well chosen to provide topics on which physical chemists, botanists, zoologists, agriculturists and those interested in fibrous materials such as textiles, wood and leather, could discuss problems common to two or more groups.

The factors governing the penetration of liquids into non-living capillary spaces, the diameter of which is greater than the range of molecular attraction, are fairly well understood. The penetration pressure, $P = 2\gamma \cos \theta / r$, where γ is surface tension, r is radius of the capillary considered as a cylinder, and θ is contact angle, determines the conditions of penetration; but the contact angle depends not only on the chemical nature of the solid and liquid, but also on the geometrical structure of the solid, and whether the liquid is advancing over a dry solid or receding from a wet one. The possible reasons for 'hysteresis of the contact angle', that is, the difference between the advancing and receding angles, received much attention; it was variously ascribed to roughness of the surface, overturning of the surface molecules, multi-molecular clusters of adsorbed water on the solid, films of air or other substances adhering

to the solid before wetting, and soaking of the liquid into the solid, below the surface, on contact. Any circumstance which increases the adhesion of water to the solid necessarily decreases the contact angle; previous wetting would increase this adhesion, if any of the above mechanisms were present, except perhaps the first. Roughness certainly exaggerates hysteresis, but is perhaps less likely to be its usual cause. As Cassie showed in 1944, the contact angle on a fabric may be very large if there are regular gaps between hairs or yarns, even though the chemical proofing is one which, on a smooth surface, would give only a moderate contact angle. The feathers of ducks, the 'plastron' or air-retaining structure with which some sub-aquatic insects are provided on their outer surfaces, and leather surfaces, are peculiarly repellent to liquid water, but are freely permeable to vapour; they have this type of structure.

In pores the diameter of which is comparable with, or less than, the range of molecular attraction, such as those in zeolites, the finer pores of charcoal, and possibly also some pores in wood, transport of water takes place in the adsorbed film, that is, by surface diffusion within the range of molecular attraction. Further, solids which contain such small pores often come under severe stress when the quantity of liquid in the pores alters; when the pores fill, as in the sorption of vapours by charcoal, the solid expands; when they empty, as in the drying of wood, the strains set up may appear as severe warping, unless the drying is very carefully done. Adsorption hysteresis may be due to extremely narrow pores being wedged open beyond the range of molecular attraction on penetration of the adsorbed substance, so that they do not spontaneously close when the adsorbate is removed.

The state of the water in films adsorbed on a coal surface was discussed, and evidence presented that it is not precisely similar to bulk water, as indeed might have been foreseen. No sharp discontinuity in the volume, or dielectric constant, occurs as the temperature is decreased to − 70° C. The conclusion drawn is that the adsorbed water does not 'freeze'. It might, however, be considered at least partially frozen by the act of adsorption; the coal surface probably orients the first layer of adsorbed water molecules, subsequent adsorbed layers being more or less oriented by contact with the first oriented layer.

'Oleophobic' solid surfaces, which have a large contact angle with oil but are themselves of a hydrocarbon nature, have frequently been reported, but an explanation of their properties is difficult and even their genuine existence was challenged. If they really exist, the adhesion of such a solid surface to liquid paraffin must be substantially less than the adhesion of a liquid paraffin to itself, despite the close similarity in chemical constitution. It was tentatively suggested, in discussion, that the solid paraffin-like surfaces may have the terminal methyl groups, those most likely to be exposed at the surface, spaced apart so as to make the adhesion to liquid paraffin less than that from a liquid paraffin surface. It was also suggested that some instances of apparent oleophobic behaviour are due to the drop of oil dissolving, locally, part of the outer hydrocarbon layers on the solid, and being compressed laterally by the surface pressure of the film remaining on the rest of the surface. In such circumstances the oil drop would show a contact angle with the surface, but that could scarcely be taken as proof that the original surface had oleophobic properties.

A very lively discussion took place on how far the movement of water and dissolved substances in plants can be explained by mechanisms known to exist in non-living pores. R. D. Preston, in his introduction to the botanical section, cast doubt on the classical view that sap is pulled up a tree by tension set up at the top of long continuous columns of water, by the evaporation from the leaves: the columns may easily be broken by air, which will prevent the tension being exerted; and sap rises even if saw cuts are made so as to break every column parallel to the trunk.

In the phloem, ordinary diffusion through the bulk of the liquid (assumed stationary) in the pores appears much too slow a process to account for the speed and quantity of transport. It has been suggested that mass flow may occur, pressure differences being set up osmotically, and maintained by the synthesis of solutes with high osmotic pressure, required for assimilation by the cells, in one region, and their oxidation in another region of the plant.

Particular attention was given, in this discussion, to the possibility of accelerated diffusion along cell surfaces. Van den Honert has shown that a good spreading oil can be transported in ample quantity along a water surface, from a high surface concentration to a low, by a difference of spreading pressure in the two regions; but the not very abundant quantitative data on the rate of transport along *solid* surfaces suggest that this is very slow in comparison with the rate on liquid surfaces. Equilibrium spreading pressures on solids are no doubt considerable; and some mobility, at any rate when the adsorbed layers are held by van der Waals' forces, is usual; but generally the rate of spreading on solid surfaces does not seem nearly high enough. Bennet-Clark and Lundegårdh revived Engelmann's suggestion (1872) that electric endosmose may sometimes be a cause of rapid transport, the bio-electric potential of some tens of millivolts being a high potential gradient if exerted across a very thin membrane. Just possibly these potential differences are caused, and maintained, by differences in the redox potential in two regions. Such suggestions are rather speculative, and seem scarcely adequate to account for the frequent occurrence of accelerated diffusion and transport along cell surfaces. It still seems probable that special 'secretory' mechanisms, utilizing the energy of oxidative or other chemical processes, operate; the nature of such mechanisms is quite unknown at present. Accelerated surface diffusion, whether general or confined to certain specific physiologically important substances, may be properly termed 'secretion', since if powerful enough it could convey a substance from a low to high concentration. Can there be, on biological surfaces, a chemical 'ciliary' structure which propels molecules specifically, or non-specifically, in one direction, as visible cilia propel water *en masse* over some living surfaces?

Discussion in the zoological section was largely concerned with water-proofing. Crisp and Thorpe demonstrated that the spiracles of sub-aquatic insects are covered by a complicated set of minute hairs which exclude liquid water in a manner similar to that in which the duck's feathers keep the bird dry. Many insects the normal habitat of which is a dry climate have a very thin layer of waxy material on their extreme outer surface, which greatly hinders the passage of water from the insect to the exterior; if this is abraded, loss of water at once increases to a dangerous amount in fairly dry air. There seems no

doubt that the cuticle of insects shows 'asymmetrical permeability', that is, moisture can pass more easily in one direction than in the other, across the cuticle. This is simply explained if the cuticle consists of two sides, one side having its permeability to water vapour decreased when in contact with a fairly high humidity, the other side being unaffected, or less affected. Such a complex membrane would pass water more easily from the less moisture-sensitive side than from the other side, because, when the higher humidity is on the side most affected by water, the permeability is decreased.

Cases of actual secretion of water into the body of an insect, from a humidity less than that in equilibrium with the interior of the insect, are not uncommon with *living* insects; one explanation which was suggested at the meeting, perhaps rather too crude to be correct, is that water is first condensed in capillaries so narrow that the meniscus on the top of the condensed column of water in the capillary is very sharply curved, so that condensation takes place below 100 per cent humidity; then the contents of the capillary tube are sucked into the insect's body from below. Very large suctions would have to be exerted.

Other subjects discussed included the behaviour of water in soils, textiles, coal and wood; also the determination of surface area by adsorption of gases, or the negative adsorption of inorganic ions in aqueous solution; and the estimation of pore size from the vapour pressure required for condensation, from the viscous resistance to flow through the porous material, or indirectly from the estimated internal surface of the solid.

The proceedings were pleasantly informal and friendly, as usual, despite the grievous loss the Society has suffered through the death of its honorary secretary, Mr. G. S. W. Marlow. Although the physico-chemical explanation of many of the phenomena which the biologists brought before the meeting remains very uncertain, and some seem to require 'biological' mechanisms much more complex than those found in non-living systems, the discussion was valuable in defining and clarifying some fundamental biological processes, as well as surveying the manner in which water interacts with several important industrial materials.

N. K. ADAM

AN EXPERIMENT IN MARINE FISH CULTIVATION

By L. H. N. COOPER and G. A. STEVEN

MANY stages of the food-cycle in the sea are much better known to-day than a quarter of a century ago. None the less, the synthesis of the scattered pieces of knowledge into a coherent whole and the assessment of the weight to be given to each has scarcely begun. An experiment in marine fish cultivation such as that of Gross, Orr, Marshall and Raymont[1] in Loch Craiglin, Argyllshire, during 1942–44, which has attempted this is therefore of outstanding importance and is worthy of a considered and vigorous criticism. The experiment suffered from many shortcomings which this group of able workers are the first to admit. The aim was set very high and the time that could be devoted to the project—mainly week-ends—under the severe stress of war conditions was inadequate. The experiment failed in its primary objective of demonstrating that marine fish cultivation can be made to pay. In the series of papers embodying the results, one senses that this failure—a failure on the heroic scale—has infected the authors with so great a feeling of disappointment that in the end they have not dared to draw from their data even those conclusions that their results would seem to justify.

One of us[2] has already stated his view that encouragement of fish growth in arms of the open sea such as the North Sea or English Channel by addition of nutrients can never be a paying concern. Indeed, in not so many years there well may be a call for means of recovering nutrients, particularly phosphorus, from the sea. None the less, he feels that the Loch Craiglin experiment shows that in selected basins and arms of the sea a satisfactory return on money expended is a definite possibility.

For the purpose of the experiments, Loch Craiglin is as unsuitable as any basin well could be; but this very unsuitability has thrown into high relief some of the adverse factors with which the marine pisciculturalist will always have to contend. The waters of the Loch were nearly always very strongly stratified. This stability was due not only to heating of the surface layer in summer but also to the presence of a chronic seal of brackish water, the salinity of which varied between 8 and 28‰. Even under unfertilized conditions, ventilation of the water by exchange of oxygen and carbon dioxide with the atmosphere must have been restricted. The addition of nutrients encouraged the phytoplankton further to strip the surface of carbon dioxide, the *p*H rising to more than 9. At the same time, at a depth of 3 metres in this very opaque stratified water, with Secchi disk readings averaging 2–3 metres, decomposition of the rain of organisms from above lowered the *p*H to 7·5. The corresponding partial pressures of carbon dioxide calculated from Buch's tables[3] would have been about 0·18 and 18×10^{-4} atmospheres, a range of one hundredfold. Animals and plants that can tolerate such a range of conditions are few. Healthy development of a balanced plant and animal community in a fertilized basin can occur only if vertical mixing and ventilation are adequate for the increased task. The authors seem to regard this ill-ventilation as an act of God about which nothing can be done. In Loch Craiglin this is probably so; but, for future development, the engineering problem of turn-over and ventilation is possibly the most important of all. Not only would improved turn-over revivify the bottom water and fertilize the surface water with carbon dioxide, but also it would circulate the added nutrients and iron to the upper layers where plants could re-use them immediately.

The water in Loch Craiglin had always a transparency far less than that of the open sea, Secchi disk readings averaging 2–3 metres, compared with the 10–15 metres in the English Channel; and the extinction coefficient for green light ranged from 0·5 to 14 (coastal water 0·2–0·3). This means that the range of depths well suited to active photosynthesis must have been measured in centimetres rather than metres. Much of the turbidity arose from biological activity within the Loch—activity that must be better understood if a way of dealing with it successfully is to be devised.

The problem of 'weeding' also arose in an acute form. When a field is infected with even such a persistent weed as charlock, a farmer has ways of dealing with it. If he does not, he will not succeed

as a farmer for long. In Loch Craiglin, bottom-living plants such as *Enteromorpha*, *Cladophora*, *Zostera* and *Ruppia* took the first large share of the added nutrients. They were weeds and needed to be treated as such, although it is hard to see how this could have been attempted with any great hope of success.

Microflagellates were richer than normal; but no clear-cut dependence on single fertilizations, light or hydrographical factors could be detected. Their growth requirements and physiology are still too little understood.

On the bottom fauna the effect of fertilization was remarkable. By the summer of 1943, sampling and computation indicated that the population density of the bottom fauna in the whole Loch had increased by an average of about 750 per cent over the pre-fertilization value; this despite heavy feeding by the large number of introduced fishes. This high value declined, however, until, in the winter of 1944, it reached a fairly stable level about 300 per cent above the corresponding pre-fertilization winter density of 1942. This increased population density produced an increase of several hundred per cent in total dry organic weight. These increases applied not to one but to all the common species useful as food. For some unexplained reason the chief two invertebrate 'competitor' species, *Anemonia* and *Ciona*, suffered a diminution in numbers. This did not apply to gobies and sticklebacks, which multiplied and flourished to such an extent that in one day, in August, they are computed to have eaten no less than eighteen times as much food as the total population of 'economic' flatfishes.

Too much weight must not be attached to the actual figures; the important point is that they undoubtedly reveal a very large increase in the invertebrate bottom fauna of the Loch due to artificial fertilization. This probably explains, in part at least, the rather unexpected finding that flatfishes in Loch Craiglin continued to feed heavily and even to grow throughout the winter.

The growth-rates of the flatfishes were investigated by means of marking experiments. These were not very successful; the marks became entangled in bottom weed and eelgrass, or inflammation of the wound interfered with growth. There was evidence, however, that unmarked plaice made the equivalent of two years ordinary growth in one year. But most work had to be done with flounders, mainly unmarked. In one year many of these showed weight increases up to about eighteen times that of the normal increment for this species in average natural conditions.

These high growth increments in large numbers of fish were not maintained. In 1943 the flatfish population was as much as 1,000 per acre (2,500 per hectare), but during the year it was very largely wiped out by cormorants, herons and at least one otter. Nevertheless, in spite of failures such as this, these experiments have demonstrated most convincingly that by the application of fertilizers Loch Craiglin, in spite of its 'dirty' bottom and unfavourable hydrographical conditions, was rapidly converted into a feeding ground approaching the richest natural feeding ground known. Although the authors have hesitated to say so, it is reasonable to believe that, if certain salient features could be dealt with, such an enclosed loch might be made far richer in fish production than anything known in Nature. These are:

(1) *Ventilation.* The addition of fertilizers must exacerbate the unbalance of carbon dioxide and *p*H that always develops in stratified water—and stratification is inevitable in summer or after heavy rainfall. Natural processes of vertical mixing need to be assisted. Here the engineer must be called in to devise some pumping or other mechanism for spreading bottom water on the surface in sufficient quantity to break down the stratification. Could wind power be used to keep the cost within economic limits?

(2) *Fixed plants.* These will thrive less well in deeper water, but are always likely to take toll of added nutrients. Their control provides a problem for research. In the absence of useful fish food-animals that can be encouraged to eat them, an economic outlet must be sought for the seaweeds and eelgrass which would make it worth while to harvest them. This would also reduce their drain on the nutrients.

(3) *Nature of the bottom and fishing gear.* The muddy bottom of Loch Craiglin was in many ways an adverse factor. In particular, catching the fish was undesirably laborious and less successful than it need be. Either special catching gear, perhaps traps, is called for, or a sandy bottom is essential.

(4) *Opacity of the water.* As much as possible of the daylight penetrating into the water needs to be available for photosynthesis. In physical terms, high quantum efficiency of photosynthesis is required. Intensive production of living material in the sea leads everywhere to production of matter, possibly dead plant pigments, that seem to be resistant to breakdown. Their presence restricts absorption of light by the pigments associated with living plant cells. Much more needs to be learned about the chemical substances which bring about light absorption and scattering in 'old water' and how they could be destroyed or turned to account.

Always when discussing marine fish cultivation, it is assumed that nutrients from terrestrial stocks are to be added to the sea. Yet the very great richness of Antarctic water in nutrient salts has come about by a process of concentration within the sea. Current systems, both horizontal and vertical, are such that the loss of nutrients caused by the rain of organic matter falling towards the bottom from the photic zone south of the Antarctic convergence is more than made up by upwelling of deeper and richer water. By contrast, in the Straits of Gibraltar, the relatively rich deep water flows out from the Mediterranean over the sill and is replaced by poorer Atlantic surface water. The net result of the exchange is an impoverishment in nutrients of this great Sea, and consequent poor fisheries. Cannot something be learned from these natural events that could be applied, for example, to a large tidal sea loch with a narrow deep entrance that could be easily dammed? Let it have two sluices, one at the foot of the dam, opened to allow deep nutrient-rich water to enter on the rising tide, the other at tide level to allow surface water, stripped of nutrients, especially in summer, to escape on the falling tide. In time, a concentration of nutrients would build up (as in the Antarctic) higher than would ever be found in the adjacent open sea, and should open up great possibilities of successful fish farming. Under these conditions it would be worth while to remove unwanted fixed plants for use as field dressings.

The cost of building such a dam solely for purposes of an artificial fishery would no doubt prove prohibitive. Equally the construction of such dams to convert tidal energy into electric power has also been burked on the grounds of cost. There should be no

loss of hydrostatic height involved in leading the water from the foot of the dam by way of a siphon through a turbine rather than from the incoming surface water, as would normally be done. The combination of simultaneous production of power and fish from the one investment might prove economic. This is another matter for consideration by engineers. In short, this unique experiment has provided such a mass of interesting and important facts as will stimulate academic research and practical endeavour in many parts of the world.

[1] *Proc. Roy. Soc., Edinburgh*, **63** (1947). An Experiment in Marine Fish Cultivation. No. 1. Introduction. By Dr. F. Gross. 1*s*. No. 2. Some Physical and Chemical Conditions in a Fertilized Sea-Loch (Loch Craiglin, Argyll) by Dr. A. P. Orr. 3*s*. No. 3. The Plankton of a Fertilized Loch. By Dr. S. M. Marshall. 2*s*. 2*d*. No. 4. The Bottom Fauna and the Food of Flatfishes in a Fertilized Sea-Loch (Loch Craiglin). By J. E. G. Raymont. 3*s*. 8*d*. No. 5. Fish Growth in a Fertilized Sea-Loch (Loch Craiglin). By Dr. F. Gross. 7*s*. 8*d*. See also *Nature*, **153**, 483 (1944); **158**, 187 (1946).

[2] Cooper, L. H. N., *J. Mar. Biol. Assoc.*, **27**, 326 (1948).

[3] Buch, K., "Der Borsäuregehalt des Meerwassers und seine Bedeutung bei der Berechnung des Kohlensäuresystems im Meerwasser". *Cons. perm. int. pour l'explor. de la mer, Rapp. et Proc.-verb.*, **85**, 71 (1933).

OBITUARIES

Prof. Alexander Ogg

For more than forty years Alexander Ogg, who died on February 23, had been by common consent the much-loved leader in his subject of physics in South Africa. A Scotsman by birth, he graduated in the University of Aberdeen under Prof. Niven and afterwards obtained his doctorate as an 1851 Exhibitioner under Nernst in Göttingen. His interest in thermodynamics arose during this period, and led to his well-known English translation of Planck's classic work on the subject. After this, he was for a time a lecturer at Aberdeen, which he left to become a master in the Royal Naval Engineering College, Devonport. In 1905 he migrated to South Africa to be the first occupant of the chair of physics and applied mathematics at Rhodes University College, Grahamstown. In so doing he became by no means the least illustrious of that band of Scottish teachers who have contributed so much to South Africa.

Ogg's new department at Rhodes College was housed in part of the old military barracks and bore the inscription "Sergeants' Mess" over its door. He set to work with great vigour and in the face of many difficulties to convert it with his own hands into a physics laboratory which would be not only the best in the country but also bear comparison with any overseas. He soon became acknowledged as an inspiring teacher and attracted to his honours courses the best brains of the College, whether they intended to become physicists or not. Year after year, in regular succession, the senior overseas scientific scholarship in the Union was won by one of Ogg's students, all of whom to-day occupy leading positions in the life of the country.

In 1917, after assisting Sir William Bragg for a time in England in military research, he moved to the University of the Witwatersrand, and in 1920 to that of Cape Town, where he remained until his retirement in 1936. When the University of Cape Town moved to Groote Schuur, he planned and fitted up the new de Beers Physical Laboratories, devoting his spare time to making them an outstanding monument to his wide experience and skill.

During his time in Cape Town, Ogg became interested in terrestrial magnetism, and when he retired from university life at the age of sixty-five he began a new one as director of the Government Magnetic Observatory, Hermanus, which again he planned and fitted up himself. Under his direction the Observatory has become well known internationally not only for its observations, which are considered to be among the most accurate in the world, but also for Ogg's papers on *K* indices of magnetic activity and on magnetic disturbances. He retired from the directorship in 1946, but maintained an active interest in the Observatory, as in all physical research in the Union, up to the time of his death.

The high standing of the subject of physics in South Africa is very largely due to Ogg's own high standards as a teacher and examiner. His students have become members of the staff of practically every university in the country, and his scholarly influence remains imprinted on both schools and universities. His time and energy, particularly in his early period, were so fully occupied with building up his departments that he had little available for research, though some valuable work on X-ray diffraction and crystal structure was done by him in Cape Town.

He was a fellow of the Royal Society of South Africa and its president for five years, a fellow of the Institute of Physics, the Physical Society, the Royal Microscopical Society and the Faraday Society. The University of Cape Town conferred on him the honorary degree of D.Sc. in 1936, and the University of Aberdeen that of LL.D. in the same year.

As a man, Ogg will be remembered for his kindliness and humour, his strict sense of justice and the great personal interest he took in his students. He always exercised an important influence on university affairs, an influence which was all the more effective because of his unassuming integrity.

B. F. J. Schonland

Mr. Harry Price

Through the death of Mr. Harry Price on March 29, psychical research has lost its most distinguished journalist and writer of popular descriptive accounts of adventures with the unknown. He was born in 1881, and from an early age was keenly interested in conjuring and magic, which soon led him to a desire to inquire more fully into the alleged physical phenomena of mediumship. An opportunity was given him in 1922 to visit Munich in order to be present at some sittings with the famous medium Willi Schneider, with whom the late Baron von Schrenck was at that time experimenting. From that period until the day of his death his interest in the problems of mediumship never weakened.

After the first properly equipped séance room had been built and opened by the Society for Psychical Research in February 1924, Mr. Price followed suit, and in December 1925 he opened what he called the National Laboratory of Psychical Research, with premises in the house of the London Spiritualist Alliance in South Kensington. From that date he pursued his inquiries and published his results with unremitting zeal and enthusiasm. His books and magazine articles were written in popular and colloquial style, and it was through them that many people became acquainted with psychical research who would otherwise have taken but little interest in the subject.

Mr. Price had a wide knowledge of his subject, and in course of time accumulated what is undoubtedly

the finest collection of books on conjuring and allied arts that exists. This library he placed on permanent loan in the University of London, with the intention of bequeathing the entire collection, together with a sum of money for its maintenance, to the University. He had long hoped that a department for psychical research might be established in the University of London or elsewhere, and the negotiations in connexion with this project were long and protracted but never came to fruition. One of the reasons for this was that Mr. Price's interest in psychical research was much more that of a brilliant journalist seeking sensational copy than that of a sober man of science studying obscure phenomena away from the glitter of *klieg* lights and the hubbub of Press conferences. It was thus that many of his results were greeted with some suspicion, especially as some of the accounts of his own experiences were unverified and in many cases unverifiable. Yet his influence on contemporary psychical research was considerable, and his position in the field he made his own is not likely to be challenged for many years.

We regret to announce the following deaths:

Sir Franklin Sibly, K.B.E., vice-chancellor of the University of Reading from 1929 until 1946, on April 13, aged sixty-four.

The Rev. Thomas Stephenson, a well-known amateur field botanist, on April 15, aged eighty-two.

NEWS and VIEWS

Félix Vicq d'Azyr (1748–94)

Félix Vicq d'Azyr, who was born at Valognes in Normandy two hundred years ago on April 23, 1748, may properly be styled the greatest comparative anatomist of the eighteenth century before Cuvier. At the wish of his father, a doctor, he went to Paris at the age of seventeen to study medicine, remaining in the capital all his life. His social success and rapid rise to fame he is said to have owed to the French naturalist, Louis Jean Martin Daubenton, whose niece he married. He became permanent secretary to the newly founded Paris Academy of Medicine and succeeded Buffon in the French Academy. He was also consulting physician to the Queen. While his name is specifically immortalized in the 'band of Vicq d'Azyr' (also described by Gennari in 1782) and in the 'bundle of Vicq d'Azyr' (fasciculus mammillo-thalamicus), he made numerous exceedingly distinguished contributions to comparative and to human anatomy. Of particular importance is his comparative study of the limbs of man and animals, which stresses the correspondence between the flexor and extensor muscles of the legs and arms. In the troubled times in which his last years were spent he frequently risked death by attending patients on the proscribed list. He is believed to have caught a chill while watching the burning of the allegorical figure of atheism, and he died on June 20, 1794, at the early age of forty-six. Vicq d'Azyr's writings were published after his death by Moreau de la Sarthe under the title "Oeuvres de Vicq d'Azyr" (6 volumes), Paris, 1805.

Fuel Efficiency Committees

When he opened the Wolverhampton Industrial Centenary Exhibition, Mr. Hugh Gaitskell, Minister of Fuel and Power, announced that he had reconstituted the Fuel Efficiency Committee organisation of the Ministry. This organisation consists of a central Fuel Efficiency Committee and a Fuel Efficiency Committee in each Region. The Fuel Efficiency Committee was first set up in September 1941, under the chairmanship of Dr. E. S. Grumell, who will continue as chairman. As now reconstituted, it will have the following terms of reference: "To advise on the application of measures promoting economy and efficiency in the use and consumption of fuel and power; to survey the progress of the organisations established for this purpose; to report the problems arising from these surveys which appear to require scientific investigation; to advise generally as to the lines on which a policy designed to raise the standards of utilization of fuel and power can best be implemented".

Many members of the previous committees have consented to serve on the new body. Other experts in different branches of fuel technology, and additional representatives of both domestic and industrial consumers have been invited to join. Liaison with both sides of industry will be ensured by the nomination of members of employers' and trade union organisations, and also with the Industrial and Domestic Coal Consumers' Councils, through their chairmen. The Regional Fuel Efficiency Committees are being reconstituted on similar lines, and their chairmen will be *ex officio* members of the main Committee. The committees consist entirely of voluntary unpaid workers.

Grants for Scientific Research in Belgium

The annual report for 1946 of the Institute for the Encouragement of Scientific Research in Industry and Agriculture, Exercice, Brussels, details the twenty-nine projects for which subsidies were granted in 1946. The largest of these, 2,800,000 francs, was to the Electrical Construction Works of Charleroi, for research on electronic tubes and their applications; a grant of 2,458,000 francs was made to the Foundation for Potato Research for investigations on the breeding of varieties resistant to virus disease, and one of 2,000,000 francs to the Belgian Institute for High Pressures for static and dynamic researches in the field of high pressures, the development of methods for determining the quality of powders and explosives and the study of the metrology of high pressures. A further grant of 1,900,000 francs was made to the Electrical Construction Works of Charleroi for the continuation and extension of research on the mercury vapour arc, while the Belgian Institute for the Improvement of the Beetroot received 1,890,000 francs for continuing agronomic, chemical, biological and mechanical investigations on the improvement of the sugar-beet. To the Union of Belgian Artificial Textile Manufacturers, "Fabelta", 992,000 francs were granted for investigations on the determination of the properties of viscose filaments, and on the deformation of threads of regenerated cellulose. A grant of 891,000 francs was made to the National Research Centre for the Study

of Animals Harmful or Useful to Agriculture, for the initiation of a study of the fauna, of means of controlling indigenous pests and nematode phytoparasites, as well as of biological control of agricultural pests. The Colonial Centre for Documentation and Co-ordination of Chemical Research received 844,400 francs for research in medicinal plants and insecticides in the Belgian Congo, while the Belgian Society of Optics and Precision Instruments received 800,000 francs for scientific and technical research on the improvement of optical surfaces, the study of optical systems corresponding with a new range of instruments and on the introduction of rational methods of manufacture into optics. Smaller grants, including 263,000 francs to the Centre for Ecological and Phytosociological Research and 162,500 francs for research on penicillin, brought the grand total to 20,801,300 francs.

Pulse-Counting Photometer

THE January issue of *Sky and Telescope* describes a new photo-electric photometer which counts the number of light pulses coming in from a star. The apparatus, known as the *RCA* 1P21 photo-multiplier tube, furnishes a strong pulse which can be amplified to operate special counters supplied by the Radio Corporation of America. In the 1P21 tube, each electron emitted when photons strike the light-sensitive surface in turn releases two to five secondary electrons from the first dynode, and repetition of this process through nine stages means that a single photon can be responsible for the emission of a million or more electrons from the last dynode. The addition of an *RCA* precision time-interval counter makes the work automatic; the observer merely sets a time-interval into a predeterminer, and the electronic devices then expose the counter to the output of the photomultiplier for a predetermined time. The number of pulses received in the interval is proportional to the light intensity of the star. Stars as faint as mag. 11·5 have been measured with the new apparatus attached to the 18-in. refractor of the Flower Observatory, and improvements now in progress may extend this by two magnitudes.

Head Wounds: Treatment and Rehabilitation

"WAR SURGERY SUPPLEMENT No. 1" of the *British Journal of Surgery*, with the subtitle "Wounds of the Head" (Bristol: John Wright and Sons, 1947. 30*s*. net), is not only a good record of surgical skill and achievement but also a fine example of British printing and publishing. Liberally illustrated by drawings and photographs, it should be a valuable work of surgical reference. There are twenty-two articles on various aspects of war wounds of the head. The first is by Geoffrey Jefferson, on "Head Wounds and Infections in Two Wars", the second by Sir Hugh Cairns on "Neuro Surgery in the British Army, 1939–45", and the third a remarkable "Atlas of Head Wounds", illustrating in colour standard operative techniques for their treatment. The remaining articles deal with other aspects of this important field of work and there are also notes on rare or obscure cases and a valuable bibliography of "Gunshot Wounds of the Head". Surgeons especially, but also bacteriologists, neurologists and others who are interested in the treatment and in rehabilitation of the patient after severe head injuries will certainly find the experience collected in this volume of very great value. They will look forward with great interest to the appearance of the three other war supplements which are being prepared. No. 2 of these will deal with Abdomino-thoracic Wounds, No. 3 with Wounds of the Extremities, and No. 4 with Plastic Surgery, including Facio-Maxillary Injuries.

Textile Institute

ACCORDING to the annual report of the Textile Institute, presented at the annual general meeting on April 21, membership increased during 1947 by more than 20 per cent, to 3,728; this is more than twice the 1943 total. Correspondingly, there has been a big increase in activity. Further new branches of the Lancashire Section were formed at Oldham and Burnley; sections and branches held more than a hundred meetings. Besides the very successful annual conference held at Portrush, two one-day conferences were held to consider "Modern Methods of Single Fibre Testing" and "End Breakages in Cotton Ring Spinning". Two scholarships were awarded, to Mr. G. H. Ewins and Mr. J. E. Booth, both of Bolton, who have now commenced degree courses in textiles at the Manchester College of Technology. The decision to award a new scholarship of a maximum value of £1,000, to be available to students in all branches of textiles, was also announced. It is hoped that the Institute will be able to ensure "the general recognition and application of technical skill and scientific knowledge within the textile industry on a scale adequate to enable the industry to maintain its place in the increasingly complex economy of a rapidly developing world. The Textile Institute must achieve the status and capacity which is required if textile technology, of which the Institute is the guardian, is adequately to meet the needs of modern times."

Health Education in Guildford

AN earnest attempt to combat infection of food and drink has recently been begun by the Guildford Health Committee and food traders of the town (*Health Educ J.*, **6**, No. 1; January 1948). A preliminary survey of 317 food premises carried out in November 1946 by health officials showed that many premises were faulty in structure and had inadequate washing and cleaning facilities and were staffed by men and women who were daily committing unhygienic practices. Instead of using legislative powers to tackle the problem it was decided to gain the willing co-operation of the manufacturers and food handlers. A Guildford Hygienic Food Traders Guild was set up to improve the sanitary arrangements in food-handling premises and to ensure that the statutory standards of food hygiene are observed, as well as to establish codes of practice for different trades which would be voluntarily accepted and applied by member firms of the food trades guild. Time was given for the necessary alterations and improvements to premises to be made, and the scheme took effect from March 1. The support and co-operation of the housewife has been sought by educational propaganda.

Plant Collecting in the Far East

DR. GEORGE TAYLOR joined Frank Ludlow and George Sherriff in 1938 for an expedition to south-eastern Tibet, and an account of the journey has recently appeared (*J. Roy. Hort. Soc.*, **72**, Pts. 4 and 5, April and May 1947), with illustrations (several in

colour) of some of the plants of significant horticultural beauty brought to Great Britain. Part of the collection is still unidentified; but the account seeks rather to portray those species which might attract British gardeners. The genus *Meconopsis* is perhaps most strongly represented, followed closely by *Gentiana*, but many other genera are mentioned. Mr. F. Kingdon Ward has also a recent short paper on his war-time explorations in Manipur (*J. Roy. Hort. Soc.*, **73**, Pt. 2, Feb. 1948). He noted many interesting plants and confirmed several earlier records by Watts and Clarke.

Natural History of Butterflies

A 20-PAGE booklet on "Butterfly Migration" by Dr. C. B. Williams, in the "Young Britain" Educational Series of the *Daily Mail*, has recently come to hand. Simply but effectively written and attractively illustrated, it is a publication with an immediate appeal to young naturalists, if not to older ones also. The photographs of the living insects by S. Beaufoy add to its merits, and the chief facts relative to butterfly migration and what to look for in this field of natural history are clearly presented. Details regarding the various publications in the series are to be obtained from the *Daily Mail* School-Aid Department, New Carmelite House, London, E.C.4. The present booklet and many of the others are priced at 1*s.*; some cost a little more, but are excellent value at this low figure.

Archæology of the Missouri Valley

THE Government of the United States is undertaking a large flood control and development programme in the Missouri Valley, and this will result in the destruction or submergence of many archæological sites which badly need study. Work in the area is a race against time, and "Prehistory and the Missouri Development Program", by W. R. Wedel (*Smithsonian Misc. Coll.*, **107**, No. 6), is a summary of what is already known about the archæology, together with an account of a preliminary survey, under the auspices of the Smithsonian Institution, done during the field season of 1946, in order to determine which sites ought to be excavated before they are overwhelmed.

A New Mathematical Journal

THE Institute for Mathematics and Mechanics of New York University, of which the director is Prof. R. Courant, has now undertaken the production of a new journal entitled *Communications on Applied Mathematics*, which will appear quarterly. The publishers are Interscience Publishers, New York and London, and the subscription is eight dollars a year. The first number, dated January 1948, contains 99 well-printed pages, on good paper, with several diagrams. Most of it consists of an elaborate investigation of non-linear wave propagation in shallow water and open channels by J. J. Stoker. There is also a shorter paper on free boundaries of an ideal fluid by M. Shiffman. The second number will contain other papers on water waves. It is not intended that the new journal shall deal only with hydrodynamics; later numbers will cover a great variety of topics, including quantum theory, elasticity, aerodynamics, combustion, kinetic theory of gases, and the numerical solution of non-linear partial differential equations. Most of the papers will originate from the Institute for Mathematics and Mechanics of New York University.

International Society of Hematology

THE International Society of Hematology will hold its bi-annual meeting in Buffalo, New York, during August 23–26. The provisional time-table allows for half-day sessions as follow: general subjects, including radioactive and stable isotopes in hæmatology; problems and diseases related to the red cells; problems and diseases related to the white cells; immunohæmatology, *Rh–Hr* (*CDE–cde*) antigens and antibodies, and hæmolytic anæmias (two sessions); coagulation problems and hæmorrhagic diseases. The chairman of the Programme Committee is Dr. Ernest Witebsky, Buffalo General Hospital, Buffalo, New York. Dr. Eduardo Uribe Guerola, Leibnitz 212, Nueva Colonia Anzurez, Mexico, D.F., is responsible for programme arrangements from South and Central America, and Sir Lionel Whitby, University of Cambridge, for papers from Europe. All scientific sessions and exhibits will be open to those interested in hæmatology. The secretary of the Society is Dr. Sol Haberman, William Buchanan Blood Centre, Baylor Hospital, Dallas, Texas, from whom further particulars can be obtained.

International Rheological Congress

AN International Rheological Congress will be held at Scheveningen (The Hague) during September 21–24. The Congress will consider theoretical problems; fundamental experimental methods; rheological properties of various systems; rheological problems in biology; and industrial applications. The plasticity of crystallized materials, soil mechanics and geophysical problems will be excluded, since other international congresses will give attention to these subjects during the year. Sectional meetings for the discussion of special subjects will be a feature of the meeting; at these meetings, every speaker will give only a short account of his paper, so that ample time will be available for discussion. Manuscripts in English or French must be received before May 1. The maximum space for a paper is 2,500 words including formulæ and diagrams, since the *Proceedings* must be limited to 500 pages. Preprints of all papers will be available at least a month in advance of the meeting. Owing to generous support from Dutch industry and scientific societies, the congress fee will be 15 florins (about £1 8*s.*); this will cover the cost of preprints, but not the *Proceedings*. The Organising Committee will help participants in obtaining accommodation at Scheveningen. The secretary of the Committee is Ir. H. C. den Daas, Julianalaan 134 (Postbox 66), Delft.

Summer School in the Physics of Solids

A SUMMER SCHOOL in the Physics of Solids, with particular reference to the properties of ionic solids, will be held in the H. H. Wills Physical Laboratory of the University of Bristol during September 8–15. Lectures will be given by Prof. N. F. Mott, Dr. J. W. Mitchell and other members of the staff of the Laboratory. A purely theoretical course on the electrical properties of ionic solids was held in 1946. The present course is intended for members of the staffs of Government and industrial laboratories who wish to familiarize themselves with both experimental and theoretical work on the properties of ionic solids, particularly in fields beyond those with which they are directly concerned. For each branch of the subject, parallel lectures will be given on the experimental side and on the theoretical side. Accommodation can be arranged at the University Hall of

Residence, Clifton Hill House. Inquiries should be addressed to the Director of the Department of Adult Education, W. E. Salt, University, Bristol 8; completed application forms should be returned by June 15.

Summer School in Metal Physics

A SUMMER SCHOOL in Metal Physics will be held in the Cavendish Laboratory, Cambridge, during August 23–September 3. The School will provide an introduction to the application of physical methods to the examination and utilization of metals, and is intended for those whose researches require a more fundamentally physical approach than is usual in ordinary metallurgical and engineering practice. The lectures and demonstrations will deal with (*a*) application of X-ray methods in the examination of metals, (*b*) physical and mechanical properties of metals. Both parts will be taken by all attending the School, and for Part (*a*) an elementary knowledge of X-ray diffraction methods and of crystal symmetry will be assumed. A detailed syllabus and form of application for admission can be obtained from G. F. Hickson, Secretary of the Board of Extra-Mural Studies, Stuart House, Cambridge, to whom the completed application form should be returned not later than June 1.

University of London: Appointments

THE following appointments in the University of London have been announced: Prof. A. C. Offord, professor of mathematics at King's College, Newcastle-upon-Tyne, since 1945, to the University chair of mathematics tenable at Birkbeck College as from October 1; Dr. R. E. M. Wheeler, director-general of archæology in India since 1944, to the chair of the archæology of the Roman Provinces tenable at the Institute of Archæology as from October 1; Miss Mary Barber, lecturer in bacteriology in the British Postgraduate Medical School, to the University readership in bacteriology tenable at St. Thomas's Hospital Medical School as from October 1; Dr. H. E. Rose, lecturer in mechanical engineering at King's College, to the University readership in mechanical engineering tenable at the College as from October 1.

The following titles have been conferred: professor of geology in the University on Dr. Leonard Hawkes (Bedford College); reader in organic chemistry in the University on Dr. A. H. Cook (Imperial College of Science and Technology); reader in chemistry in the University on Dr. H. G. Poole (University College); reader in agricultural chemistry in the University on Dr. R. L. Wain (Wye College).

The degree of D.Sc. has been conferred on Franz Bergel (Lister Institute of Preventive Medicine).

Colonial Service Appointments

THE following appointments in the Colonial Service have been announced: J. L. Fleure, survey probationer, Malaya; R. W. Butler, veterinary officer, Tanganyika; R. M. S. Neave, veterinary officer, Kenya; D. Bradwell, analyst, Medical Department, Cyprus; R. L. Hartley, agricultural education officer, Fiji; C. W. D. Kermode, assistant conservator of forests, Tanganyika; J. P. Oliver, agricultural officer, Falkland Islands; L. Ross, assistant meteorologist, Nigeria; A. J. Willis, assistant meteorologist, Nigeria; E. W. Leach (deputy director of agriculture, Trinidad), director of agriculture, Trinidad; J. C. Muir (director of agriculture, Trinidad), director of agriculture, Tanganyika; F. W. Toovey (principal research officer, Oil Palm Research Station, Nigeria), officer-in-charge, Oil Palm Research Station, Nigeria; H. Fraser (assistant conservator of forests, Tanganyika), senior assistant conservator of forests, Tanganyika; H. R. Herring (assistant conservator of forests, Tanganyika), senior assistant conservator of forests, Tanganyika; A. L. C. Thorne (veterinary officer, Gold Coast), veterinary education officer, Nigeria; J. Y. Moggridge (entomologist, Tsetse Research Department, Tanganyika), director, Tsetse Research Control Department, Tanganyika; H. C. Smith (senior assistant livestock officer, Tanganyika), livestock officer, Tanganyika; J. F. B. Watling (senior inspector of produce, Nigeria), principal produce inspector, Nigeria.

New Satellite of Uranus

IT is reported from the McDonald Observatory, Texas, that a new satellite of magnitude 17 to the planet Uranus was found on a plate taken on February 15, at the Cassegrain focus of the 82-in. telescope. Two other plates taken on March 1 confirmed the new discovery. Its distance from the planet is about 0·00082 astronomical unit, or 76,500 miles, which implies that its period of revolution is about 31 hours.

Acetylation of Sugars

REFERRING to the communication by S. D. Nicholas and Dr. F. Smith entitled "Acetylation of Sugars" (*Nature*, March 6, p. 349), Dr. P. H. Plesch, Chemistry Department, University of Manchester, remarks that the use of perchloric acid as catalyst in the acetylation of sugars is by no means new; it has been discussed in some detail by D. Krueger and W. Roman (*Berichte*, **69**, 1830 (1936) and *Angew. Chem.*, **47**, 58 (1934)).

Announcements

MR. NORRIS E. DODD, Under-Secretary of Agriculture in the United States, has been appointed director-general of the United Nations Food and Agriculture Organisation, in succession to Sir John Boyd Orr, who has retired. The British Minister of Food has agreed to release Sir Herbert Broadley, deputy secretary, Ministry of Food, for appointment as deputy director general of the Organisation.

THE Fison Lectures of the Animal Health Trust will be delivered by Prof. L. Seekles, of the Veterinary Biochemical School of the University of Utrecht, at the Kingsway Hall, London, on May 10 and 12. He will discuss mineral disturbances in cattle, gastro-intestinal autointoxication in cattle and horses, and conditional deficiencies of trace elements in cattle. Further particulars may be obtained from the Animal Health Trust, 232–235 Abbey House, Victoria Street, London, S.W.1.

THE Ministry of Agriculture and Fisheries and the Department of Agriculture for Scotland propose to award, for the next academic year, a limited number of postgraduate scholarships in husbandry, agricultural economics, statistics and agricultural and dairy engineering. Particulars may be obtained from the Secretary, Ministry of Agriculture and Fisheries, 2 Cambridge Terrace, Regent's Park, London, N.W.1, or the Secretary, Department of Agriculture for Scotland, St. Andrew's House, Edinburgh 1.

ERRATUM. In the note on "American Summer Scholarships for European Students" (*Nature*, April 17, p. 593), it should have been stated that applicants must be *less than* thirty-five years of age.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Purification of Anti-pernicious Anæmia Factors from Liver

We have now prepared from ox liver two red pigments both highly active in pernicious anæmia. The crude extract was purified by the methods employed by Emery and Parker[1] and then by repeated chromatography. Full details of these techniques will be offered for publication later. Recently we have used as starting material a proteolysed liver extract made on a manufacturing scale; this has given better yields of a product differing slightly in chromatographic behaviour, and of higher activity. Some preparations of both types have been separated by partition chromatography into two red fractions; the proportions suggest that one arises from the other by proteolysis.

The development of fractionation methods was made possible by the collaboration of Dr. C. C. Ungley, who carried out more than eighty clinical tests on our materials. After it became clear that activity and colour are inseparable, this property was used as a guide in cutting chromatograms. With the invaluable assistance of Mr. L. F. J. Parker, four tons of liver have to date been fully processed, yielding barely a gram of red materials from six separate lots of liver. The minimum effective single dose for the best four preparations from non-proteolysed liver are assessed at about 0·6 mgm., while proteolysed liver has yielded one preparation L.E.445 effective at 0·3 mgm. though not fully purified. It was also effective in three cases of subacute combined degeneration of the spinal cord. A recovery of about 25 per cent of the original clinical activity was achieved in this purification. Ten batches of red materials have all proved clinically active (twenty-six cases in all).

A recent preparation, which appeared to have reached the limit of purification by chromatography, was shown by electrophoresis on the Tiselius apparatus to be still not homogeneous. After the action of mixed bacteria, it was susceptible to further chromatographic purification. The resulting product had eight times the intensity of colour of L.E.445. It has not yet been tested clinically; if activity remains proportional to colour, it should be effective at 0·04 mgm.

The products are amorphous solids having about the colour of cobalt salts, but they show only general absorption of visible and ultra-violet light with very slight steps at 505 and 275 mμ. The low intensity of absorption precludes the presence of more than a few per cent of such bodies as folic acid or xanthopterin. Ultra-violet light produces a very faint blue fluorescence (probably due to a trace of impurity); this is abolished by hydrosulphite, while the colour shows only a slight change of shade. Dr. R. A. Kekwick at the Lister Institute kindly examined a sample in the ultra-centrifuge and reported no sedimentation boundary even at 250,000 *g*, suggesting a molecular weight well below 10,000. The diffusion method has indicated molecular weights of about 3,000 for the pigments from both proteolysed and non-proteolysed liver. We are indebted to Dr. J. E. Page for these determinations and also for polarographic examination and electrometric titration, neither of which revealed any characteristic steps. The optical rotation of various imperfectly purified specimens has ranged from $[\alpha]_D - 150°$ to $-200°$. There is a gradual change in colour from red to orange on exposure to daylight, accompanied by a marked change in chromatographic behaviour.

Our products are exceedingly soluble in water and not readily salted out; they are also soluble in nearly anhydrous alcohol, in acetone containing only a few per cent of water, and in glacial acetic acid; but not in ether, chloroform or non-polar solvents.

Chemical examination has not proceeded very far. Various lots have contained 11·7–13·9 per cent nitrogen. Washing a solution in phenol with dilute acid removed calcium and a little sodium; the phenol solution left a negligible ash. Amorphous precipitates are given by Reinecke acid, rhodanilic acid and phosphotungstic acid. Warm dilute alkali has no effect on the colour, but boiling normal soda quickly destroys it. On the other hand, the colour is remarkably resistant to acid hydrolysis and partially survives boiling with 6 *N* hydrochloric acid for twenty-four hours. After boiling with *N* hydrochloric acid for one hour the pigment is very readily extractable by *n*-butanol. From 23 to 50 per cent of the original weight appeared in the butanol extract, depending on the purity of the preparation. It appears to contain two pigments, one acidic and readily extractable from the butanol with aqueous alkali, the other neutral; the latter is readily soluble in chloroform, the former only slightly; both are insoluble in ether; neither is identical with the photolysed product. These substances have not as yet been examined further.

The residual aqueous acid layers have contained peptides; after further acid hydrolysis these have been examined by Mr. G. A. Childs and Dr. W. F. J. Cuthbertson, by chromatography on paper and (after acetylation) on silica, and by microbiological assay, respectively. Proline, hydroxyproline, leucine, serine, glutamic acid, and *p*-aminobenzoic acid have been detected; but differences in the results for different preparations make it probable that some of the amino-acids arise from peptide impurities.

The following conclusions appear warranted. Our two pigments are differing forms of the classical liver factor first postulated by Minot and Murphy twenty-two years ago[2], and not some incomplete substitute, such as folic acid or thymine. Whatever deficiencies may be found with other macrocytic anæmias, true pernicious anæmia and its associated neurological disturbances do not require a multiplicity of factors as postulated by Jacobson and SubbaRow[3] and others, but respond to a single factor. With an effective dose equivalent to some 20 μgm. daily (possibly 2·5 μgm. only) this is one of the most potent of known physiologically active substances.

Addendum. Since this letter was written, we were privileged, through the courtesy of a confidential disclosure by Dr. R. T. Major of Merck and Co., Inc., Rahway, New Jersey, to read prior to publication the paper by E. L. Rickes, N. G. Brink, F. R. Koniuszy, T. R. Wood and K. Folkers (*Science*;

in press), on the isolation of crystalline vitamin B_{12}, which appears to be the pure anti-pernicious anæmia factor.

E. Lester Smith

Research Division,
Glaxo Laboratories, Ltd.,
Greenford.
April 9.

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A New Extraction Procedure for the Preparation of Heparin

The usual method of preparing heparin, due to Charles and Scott[1], involves rough extraction of tissues with alkali and subsequent tryptic digestion of the protein precipitate.

Special investigations, which will be reported elsewhere, made it highly desirable to prepare heparin by means of milder extraction methods avoiding the use of alkali. For this purpose, a number of salt solutions of different concentrations were tested. A 10 per cent calcium chloride solution, as used by Meyer *et al.*[2] for the extraction of chondroitin sulphuric acid, proved to be ineffective, and so did several other salt solutions. It was found that solutions of potassium thiocyanate exert a pronounced power of extracting fairly quickly and completely the mast cell granular substance from various tissues (liver and skin). Using *M* potassium thiocyanate solution for twenty-four hours, we obtained about 90 per cent extraction of the metachromatic material in ox liver. Histochemical examination of the tissue residues (cf. Sylvén[3]) showed only insignificant amounts of metachromatic substances left after such extraction. Metachromatic material was not found to adhere to other constituents, such as collagen, as it often does when previous methods are used.

After the extraction, the potassium thiocyanate was readily removed by dialysis. The following fractions then remained to be analysed: tissue residue, precipitate, supernatant and dialysate. The different fractions were treated by tryptic digestion according to Charles and Scott, and the heparin contents were assayed by estimating the anticoagulating effect by means of the thrombin method according to Jaques and Charles[4]. The following amounts of heparin expressed in mgm. 'standard heparin' according to Jorpes[5] were found:

	Amount of heparin obtained from ox liver
Tissue residue	5·5 mgm./kgm.
Precipitate	56·3 ,,
Supernatant	0 ,,
Dialysate	0 ,,
	Total 61·8 ,,

Obviously, the extracted substances displaying heparin activity were precipitated following the removal of thiocyanate. The heparin precipitated during dialysis seems to be bound to proteins. The complex is split by trypsin treatment, and afterwards almost all the heparin can be recovered. The collected yield tallies well with that reported by Wilander[6] (56–75 mgm./kgm. ox liver).

The properties of heparin prepared in this way will be described elsewhere.

We wish to express our thanks to the Consul General, Axel Ax:son Johnson, Stockholm, for financial support.

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Robert Jensen
Bengt Sylvén

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Radiumhemmet, Stockholm.
Jan. 10.

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Effect of Thyroid Deficiency on the Level of Pseudo-Cholinesterase in the Plasma of Rats

The effect of thyroid deficiency on the level of pseudo-cholinesterase in rat plasma has been examined in the following experiments.

Adult male Wistar rats (200–400 gm.) were used. They were maintained on a diet of chow ('Purina') which has been shown to be adequate for normal growth in the rat colony. All animals were killed by exsanguination through the jugular vein, and plasma from the oxalated blood was used for estimating pseudo-cholinesterase activity. The determinations were carried out by the method previously described[1]. Group I consisted of twenty-seven normal animals which served as controls. Group II was made up of sixteen animals which survived thyroidectomy. In this operation the removal of varying amounts of parathyroid tissue could not be avoided. To offset the effects of parathyroidectomy, daily subcutaneous injections of 2 ml. of a 5 per cent calcium gluconate solution were given for a period of seven days. The animals were killed fourteen days after operation; this time interval seems sufficient for the recovery of the level of pseudo-cholinesterase from the transient decline resulting from surgical intervention[2]. To exclude the possibility that the effects observed were due to parathyroidectomy rather than thyroidectomy, a third group of fifteen rats was treated with thiouracil. These rats received for a period of 23–27 days a water ration containing 0·06 per cent thiouracil. With an average daily intake of 20 ml. of water, the thiouracil consumed by each rat was thus in the neighbourhood of 12 mgm. a day.

It will be seen from the figures in the accompanying table that thyroidectomy and treatment with thiouracil cause an increase in the level of the pseudo-cholinesterase of the plasma.

Level of activity* of pseudo-cholinesterase in the plasma of male rats

Group	Normal I	Thyroidectomized II	Thiouracil-treated III
Number of animals	27	16	15
Average activity	41·0	97·1	117·3
Standard error	2·3	8·7	10·6

* μl. Carbon dioxide evolved by 1 ml. plasma in 20 minutes. Substrate: benzoylcholine chloride (0·056 *M*).

A statistical analysis of the results obtained reveals that the probabilities for the differences in pseudo-cholinesterase activity arising on a basis of pure chance

are: for Groups I and II, $2{\cdot}0 \times 10^{-2}$; for Groups I and III, $2{\cdot}6 \times 10^{-12}$; and for Groups II and III, $1{\cdot}3 \times 10^{-1}$. Thus the differences between the levels of pseudo-cholinesterase in the plasma of normal and thyroidectomized and of normal and thiouracil-treated animals are highly significant, whereas the difference between the effect of thyroidectomy and treatment with thiouracil is of doubtful significance.

Since the physiological function of the pseudo-cholinesterase is still obscure, any attempt to interpret the results outlined above would seem premature. This investigation is being continued and the experimental findings will be discussed in greater detail elsewhere.

This research was aided by a grant from the Banting Research Foundation to one of us (M. N.).

R. D. Hawkins
B. Mendel
M. Nishikawara

Banting and Best Department of Medical Research, Banting Institute, University of Toronto.
Jan. 9.

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Phase Memory of the Ear: a Proof of the Resonance Hypothesis

No experiment has hitherto been recorded which is decisive for or against the resonance hypothesis. The properties of the ear are such that it is difficult to construct an experiment of which the result is neither obscured by an unavoidable margin of error nor capable of alternative interpretations. We believe that the following experiment is unobjectionable on either of these grounds and constitutes a valid proof that the resonance hypothesis is true, and that the resonators of the ear (at all but the lowest audible frequencies) are only lightly damped.

We present to the ear of an observer two alternative stimuli. One stimulus consists of a train of oscillatory pulses of sound, each pulse of the form $F \sin 2\pi ft$ and n cycles duration separated from the next by a silent interval of length corresponding to m cycles, n and m being integers. The other stimulus, which can be substituted for the first by the operation of a single switch, is identical in all respects save that the phase of alternate pulses is reversed. Precautions are taken to ensure that the wave-form of the sound in air corresponds with high accuracy to the intended wave-form. If the observer can distinguish between the two stimuli, it follows that the oscillations in the ear initiated by each pulse have not died down to insignificance at the onset of the next, for the energy of every pulse of both stimuli is identical in magnitude and spectral distribution. No frequency analyser could distinguish between the two stimuli unless its oscillatory time constants were so large that phase was 'remembered' across the silent interval.

We find, for example, that at a frequency, f, of 5 kc./s., an intensity of about 20 db. above threshold and n approximately 10 (the value of n is not critical), the stimuli are readily distinguished provided that m is not much greater than 30. The energy in a resonator decays at the rate of $\frac{20\pi}{Q} \log_{10} e$ db. per cycle ($\doteq \frac{27}{Q}$ db. per cycle), where Q defines the degree of resonance in the usual way. It is evident that if Q were low, say, 10, the residual energy at the end of a silent period of 30 cycles would be insignificant (40 db. below threshold). The only explanation of the result is that at this frequency the value of Q must be so high that the residual energy at the end of the silent period is a significant fraction of the energy available from the next pulse. This indicates a value for Q of at least 100 and probably substantially more.

We have published[1] an estimate of Q for the resonators of the ear by a different method, giving a value of about 250 at 5 kc./s. The experiment described above constitutes a proof that our previous interpretation was correct, and that in fact it was the Q of the resonant elements which we determined and not, as has been suggested, a time constant associated with some subsequent process in the chain which results ultimately in a sensation in consciousness. It also strongly supports the conclusion that, in essence, Helmholtz's interpretation of the structure of the ear was correct[2]. Consequently the results of experiments which have been interpreted as indications that the resonators of the ear were highly damped must be re-examined. So far as we can see, an alternative explanation consistent with the resonance hypothesis is in every case the probable one.

One of us (T. G.) was assisted by a grant from the Medical Research Council.

R. J. Pumphrey
T. Gold

Zoological Laboratory, Cambridge.
Jan. 17.

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[2] Helmholtz, "Tonempfindung" (1862).

Osmotic Work Performed by the Renal Tubules

A method for the derivation of an 'index of renal tubular activity' has recently been suggested by Barclay and Kenney[1]. An alternative method of deriving this index, which is suggested in this note, lends support to Barclay and Kenney's claim that their ratio represents tubular activity.

Consider a small region of the tubule, where the concentration of the solute in the tubular urine exceeds the concentration of the same solute in the plasma by a small amount, dC'. Let the osmotic pressure difference between the plasma and the tubular urine in this region be equal to p', for this particular constituent solute.

Then:

$$p' = RT.dC',$$

where R is the gas constant, and T the absolute temperature.

Now the work performed in withdrawing a volume of water, dv, against this osmotic pressure, p', is

$$w' = RT.dC'.dv.$$

To obtain the total work performed along the whole length of the tubule, we can take the sum of the work done in the regions from the glomerulus to the end of the tubule: that is, from the region where $dC' = 0$, to the region where $dC' = (U' - P')$, U' and P' being the concentrations of the substance in the urine and plasma, respectively.

If the work done along the whole length of the tubule is summed, the value of dv may be written as a constant, k; and dC' becomes $(U' - P')$. If this

value for the work along the whole length of the tubule is referred to a constant rate of filtration of the solute under consideration, we can obtain an expression for the total work, per mole of the solute filtered :

$$W_s' = RT.k.(U' - P')/G.P', \quad (1)$$

where G represents the glomerular filtration-rate.

Similarly, for a second solute :

$$W_s = RT.k.(U - P)/G.P. \quad (2)$$

Therefore the ratio of the osmotic work performed in withdrawing water against the osmotic pressure of the second solute to that performed in withdrawing water against the osmotic pressure of the first is given by :

$$W_s/W_s' = P.P'(c - 1)/P'.P(c' - 1),$$

where $c = U/P$ and $c' = U'/P'$.

$$\text{Hence } W_s/W_s' = (c - 1)/(c' - 1). \quad (3)$$

Where the 'reference solute', represented above by U', P', etc., is a substance which is neither excreted nor reabsorbed by the tubule cells, this ratio becomes identical with that proposed by Barclay and Kenney.

The above equations hold in the case of non-electrolytes. For electrolytes we must consider the activity coefficient. For two electrolytes having the same values for activity and dissociation, equation (3) above will hold. If we consider any electrolyte, and compare it with a reference solute, such as inulin, we are fulfilling the conditions under which the index of Barclay and Kenney is applied.

This would indicate that the index, E, referred to above, represents the ratio of the osmotic work performed in withdrawing water against the osmotic pressure of a particular solute, to that performed in withdrawing water against the osmotic pressure of a solute which is neither excreted nor reabsorbed by the renal tubules.

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White-eyed Mutants of Diptera

Recently, Sturtevant[1] has criticized work on white-eyed mutants of *Culex*[2], *Calliphora*[3] and *Phormica* (= *Phormia*)[4], on the grounds that such mutations are not comparable with white-eyed types in *Drosophila*. Sturtevant claims that while there are two pigments, a red and a brown, in the wild-type eye of *Drosophila*, there is only one pigment, a brown, in *Calliphora*, and that this is the usual condition in insects. Thus, the wild-type eye of *Calliphora* would be like the brown mutant of *Drosophila* in which red pigment is absent ; and, moreover, in that case it would not be possible to distinguish morphologically white, vermilion, cinnabar and scarlet mutants in *Calliphora* or in other Diptera in which red pigment is not present in the wild-type eye. In support of this view, Sturtevant quotes the work of Becker[5] on the eye-pigments of Arthropods.

Microscopical examination of the wild-type eye of *Culex pipiens* confirms the absence of red pigment granules in this species ; but it is only necessary to tease out in saline and examine microscopically an adult wild-type eye of *Calliphora erythrocephala* to prove conclusively that abundant red pigment granules are present. In a paper now in the press[6], I have shown that during pupal life the sequence of pigment formation in *C. erythrocephala* is yellow, brown and red. Moreover, there is a close parallelism between *Drosophila* and *Calliphora* both in the sequence of development of pigment granules and in the distribution of the different types of granules in the various pigment cells of wild-type eyes, except that in *Calliphora* the late-phase deposition of pigment and the appearance of red granules do not occur until a few hours before the emergence of the adult fly (at 24° C.). In the mature wild-type eye of *C. erythrocephala*, red pigment granules are present in the basal regions of the primary pigment cells and are densely packed throughout the body and fringes of the secondary pigment cells. Brown pigment granules are densely packed throughout the primary pigment cells except for their basal regions, but occur only in the distal tips of the secondary pigment cells.

I have shown[7] previously that the nature and location of the red and brown pigments in *Calliphora* render possible the occurrence of 'red' mutants as in *Drosophila* ; but this paper, which followed that in which the white-eyed mutant of *Calliphora* was described[3], apparently has been overlooked by Sturtevant. It was shown that, in certain circumstances, namely, keeping developing pupæ at about 4° C., it is sometimes possible to induce the formation of red pigment granules in the eyes of white-eyed mutant females of *Calliphora*. In such cases red is present in the absence of brown pigment, and the eye of the adult female is 'pink' or 'red'. This shows that potentially the 'red' series of mutants is possible in *Calliphora* in the absence of brown pigment ; and, presumably, in the absence of 'red', a series of brown mutants could appear. Finally, the absence of *both* red and brown pigments gives the white-eyed mutant.

It can be concluded, therefore, that in the wild-type eye of *Calliphora erythrocephala* both red and brown pigment granules are present. In mutant forms the red pigment may be present in the absence of brown. In the white-eyed mutant both red and brown pigments are absent. There is a close parallelism between the type, development and distribution of pigment granules in wild-type eyes of *Drosophila* and of *Calliphora*.

There is thus no basis for the contention of Sturtevant that the white-eyed mutation which I have described in *Calliphora erythrocephala* is not comparable with white-eyed types in *Drosophila*. The main interest, however, of the white-eyed mutant of *Calliphora*, as I emphasized in previous papers, is that, in spite of the similarity to *Drosophila* in details of type and distribution of pigment granules and in the location of the mutant gene in the X-chromosome, there is a fundamental difference in the mode of inheritance of the mutant gene in *Calliphora*. The white-eyed gene in *Calliphora* is sex-linked, as in *Drosophila* ; but, as I have shown[3], it is unique among known eye-mutants of *Diptera* in being sex-limited and appearing only in the double recessive female. This sex-limitation is due to the presence of an allelomorph for wild-type eye in the Y-chromosome, which is dominant over the recessive mutant gene in the X-chromosome. The male *Calliphora*, therefore, never manifests the white-eyed character even when it carries the mutant gene in the X-chromosome of the XY pair in this sex. In Diptera the only other comparable cases of sex-limitation of mutant genes, caused by the presence of normal allelo-

morphs in the Y-chromosome, are the mutant 'bobbed' described by Mohr[8] in *Drosophila melanogaster* in 1923 and the 'lethal' described by Schubel[9] in 1934 in the same species.

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Action of Heating on *Rh*-Positive Human Red Cells

Lubinski and Portnuff[1] have demonstrated that heating at 56° reduces or destroys the agglutinability of *Rh*-positive cells by anti-*Rh* sera. They have studied also the action of diluted formalin, which seems to be somewhat similar. Many workers have observed that preservation in saline affects the *Rh*-positive cells in the same way and recommend the use of fresh suspensions when performing *Rh*-testing.

These facts lead to the idea that the *Rh* receptor is probably more superficial or fragile than the *A* and *B* receptors, for example. We have tested this idea by the following experiment: 1 ml. of *O Rh*+ (*CDe*, *cDE*) cells are washed three times and suspended in an equal volume of saline adjusted to *p*H 7·2. The mixture is heated for fifteen to twenty minutes in a water-bath at 56° C., and the cells separated from the medium by centrifuging. The cells are washed three times and distributed in a series of titrations with a powerful anti-*Rh* (anti-*D*) serum. Controls are made with unheated *Rh*+ and *Rh*− (*cde*, *cde*) cells and with heated *Rh*− cells. It is easily verified that heating abolishes the agglutinability of the *Rh*-positive cells. The supernatant fluid to both *Rh*+ and *Rh*− heated cells is mixed with an equal volume of anti-*Rh* serum and allowed to stand at room temperature for half an hour. The two mixtures are then titrated in saline with fresh *Rh*-positive cells. In these conditions, a marked inhibition effect takes place in the first series (supernatant fluid of *Rh*+ cells), while the second shows no evident change in the anti-*Rh* titre.

This experiment was performed with several anti-*Rh* sera, and the same results were obtained.

It appears that heating at 56° C. affects the agglutinability of *Rh*-positive cells by splitting off from the surface of the cell a substance which diffuses in the medium; this may prove to be the *Rh*-receptor.

We are indebted to Dr. R. R. Race and A. E. Mourant for having given us the test-sera used in the genotype determination.

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A Method for Estimating Percentage Germination of Fungal Spores

METHODS previously used for estimating the percentage germination of fungal spores have involved hanging-drop or slide cultures. The environmental conditions, when using these methods, have always been difficult to standardize, though it may be argued that for pathological work they simulate those existing on the surface of fruits and leaves.

We have evolved, during fermentation studies, a method which could be applied to fundamental investigation of the physiology and biochemistry of spore-germination. This method possesses the following advantages: (*a*) conditions are readily standardized; (*b*) it is rapid and easily operated; (*c*) large serial samples can be taken from the same population; (*d*) the samples can be kept for further reference.

The technique involves addition of spores to a liquid nutrient medium contained in a plugged vessel so that the final concentration is not less than 1×10^6 spores per ml. of medium. The vessel is shaken on a rotary or reciprocal shaking machine at a known temperature, and samples are taken at intervals. The spores in the samples are fixed and afterwards examined as convenient.

The degree of accuracy of this method is illustrated by the results of the following typical experiment. Conidia of *Penicillium chrysogenum Q* 176 were used. Each of eight 750-ml. conical flasks containing 100 ml. of a nutrient medium was inoculated with 1×10^6 conidia. The flasks were maintained at 24° C., on a rotary shaker. Later, when germination was about 50 per cent, three samples were taken from each flask and fixed in 10 per cent formalin. Three counts per sample, each of about 500 spores, were made.

A statistical analysis of the results showed that no significant variation existed between the repeat samples from the flasks, the repeat counts per sample and the mean count from flask to flask. The variation between the nine counts within each flask was not greater than the theoretical error of counting[1]. The conidial suspension was thus uniform, was capable of accurate sampling and remained stable. The theoretical standard error of percentage germination is $100\sqrt{n(N-n)/N^3}$, where N is the total number of spores counted and n is the number germinated. For the results of this series, this was approximately 2·2 per cent actual.

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A Rare Cœlom-Dwelling Trematode

CŒLOM-dwelling trematodes are very rare. The only monogenetic form ever found in the cœlom of a vertebrate is *Dictyocotyle cœliaca* Nybelin, 1941. A solitary specimen was found at Göteborg on April 1, 1940, attached to the surface of the liver in a ray (*Raja lintea* Fries) caught the previous day near Skagen. At first sight the trematode was mistaken for the well-known cloacal parasite *Calicotyle kroyeri*, but closer inspection revealed several distinctive characters, notably the irregular arrangement of numerous

Calicotyle cœliaca: FIRST SPECIMEN. NEGATIVE PREPARED BY MESSRS. H. MALIES AND M. V. SALMON; PRINT BY WALLACE HEATON, LTD.

shallow loculi on the posterior disk (opisthaptor), which was devoid of hooks, the reticular nature of the testes and the five finger-like terminations of the filiform ovary[1]. In contrast, the opisthaptor of *Calicotyle* has one central loculus and seven peripheral loculi and bears one pair of hooks with recurved points, the testes are diffuse and follicular and the ovary terminates in a single lobe.

A second specimen was afterwards found among specimens of *Calicotyle kroyeri* in the Natural History Museum, Göteborg. It had been found by Swenander thirty-five years earlier in the cœlom of a starry ray (*Raja radiata* Donovan) caught near Trondhjem, and was somewhat deformed. Three specimens found several years later at Cambridge on the liver of a young skate (*Raja* sp.) obtained from Plymouth were mature but mutilated, each of them having lost the opisthaptor[2]. Thus, until the present time, only one good specimen of this species was known.

In my recent book[3] I commented on the difficulty of resolving the taxonomic status of *Dictyocotyle cœliaca*, which I chose to regard as an abnormal form of a species of *Calicotyle*, probably *C. kroyeri*, which had entered the cœlom of the host by way of one ot the abdominal canals and had either failed to perfecf the larval haptor normally or else regenerated an abnormal haptor after losing the normal one. In the absence of young forms we cannot improve on these speculations; but as two new adult specimens have turned up in Britain, some further comments are called for. The specimens came to me as stained whole mounts through the courtesy of Mr. Eric B. Francis, from the Zoological Laboratory, University of Sheffield. They were found on the outside of the stomach in a thornback ray (*Raja clavata* L.) during the course of a dissection. About twenty other rays of the same batch (believed to have been landed at Brixham) were examined for similar parasites, but without success.

Both specimens are somewhat larger than Nybelin's specimen *A*, being 8·3 mm. and 8·1 mm. long and 6·3 mm. and 6·0 mm. broad (0·76 and 0·73 body-length), but smaller than his specimen *B* which, to judge from a figure and scale, must have exceeded 11 mm. in length. The unarmed, multiloculate opisthaptor is about 2·5 mm. in diameter (0·3 body-length) in each specimen, that is, relatively large, and the oral sucker is about 1·0 mm. broad and 0·7 mm. long. In other respects the specimens display the distinctive characters described by Nybelin; the reticular testes occupy most of the space available in the mid-body, and in front of them is seen the thread-like ovary with its five almost spherical terminations, each about 0·1 mm. in diameter (see reproduction). Other characters include well-developed glands associated with the base of the pharynx, the mean size of which is 0·42 mm. × 0·37 mm., intestinal crura with short and simple diverticula and also larger, compound outgrowths in the posterior region, well-developed vitellaria and shell glands, a common genital atrium and pore, complicated male genital organs—including a cuticularized penis—and a pair of vaginæ. What is almost certainly an extruded egg is caught on a fold of the body margin in one specimen; it is pyriform, measures 0·186 mm. × 0·100 mm. and has a single polar filament 0·019 mm. long.

With this confirmation of Nybelin's observations on the cœlom-dwelling trematode from rays captured in the Skager Rak, the North Sea and the English Channel comes the conviction that it deserves the status of a species, but is a species of *Calicotyle*, namely, *C. cœliaca* (Nybelin, 1941). The location in the host indicates only deeper penetration, for *C. kroyeri* and *C. affinis* enter the rectum and rectal gland of *Chimæra monstrosa*, *C. stossichi* enters the rectum of *Mustelus lævis* and *C. inermis* and lives in the oviducts of *Pristiophorus cirratus*. The absence of hooks on the opisthaptor is also a character of the last-named species. Little can be said at present about the loculi on the opisthaptor, except that they number about one hundred and vary in degree of development (see reproduction).

For further study of this obscure and interesting trematode new specimens are needed, particularly young forms, and I hope that a look-out will be kept for them not only in the cœlom, but also in locations such as the rectum and the oviducts, in laboratories where skates and rays are dissected.

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Interspecific Fertilization in Ascidians

THE only experimental work on interspecific fertilization in Ascidians known to me is that of Reverberi[1], who succeeded in fertilizing *Ciona intestinalis* eggs with *Phallusia mamillata* sperms after removal of the egg membranes. He availed himself of Morgan's observation that in *Ciona* only the egg membranes oppose self-fertilization.

Following Prof. Reverberi's suggestions, interspecific crosses have been tried between eggs and sperms of five species of Ascidians: *Ciona intestinalis* (Lin.); *Phallusia mamillata* (Cuv.); *Ascidia malaca* (Traust.); *Ascidia mentula* (O. F. Müller); *Ascidiella aspersa* (O. F. Müller). The experiments were carried out during September–December, 1947, at the Zoological Station of Naples.

Egg membranes were removed by means of steel needles; chemical methods (such as digestion by enzymes from Decapod hepatopancreas) were avoided in order not to modify the egg cortex. The preliminary results may be summarized as follows.

Fertilization with heterospecific sperms succeeded in every case, except where *Ascidiella* sperms were used: it was observed that these sperms very rarely fertilize eggs of their own species after removal of the egg membranes. Probably this result is connected with the fact that *Ascidiella* eggs, which normally are buoyant, sink when their membranes are removed. The percentage of fertilized eggs varied considerably in the different kinds of crosses, but was fairly constant in experiments with the same cross. The lowest percentage was obtained with *Ciona* sperms.

In no case did interspecific fertilization succeed with eggs still inside their membranes, in spite of the fact that in certain species (*Phallusia*; *Ascidia mentula*), unlike *Ciona*, self-fertilization is a normal process.

Time intervals between sperm addition and actual fertilization varied widely, even in the same experiment (from a few minutes, as normal, to more than twenty-four hours). This result is perhaps correlated with enzymatic activity of the sperms. Sperms of the same *Ascidiella* specimen clotted constantly around the eggs of certain species (*Phallusia*; *Ascidia malaca*), but not of others (*Ascidia mentula*).

In a high percentage of cases fertilized eggs developed. In the following cases normal tadpoles were obtained: ♀ *Phallusia* × ♂ *A. mentula* (27 per cent); ♀ *A. malaca* × ♂ *Ciona* (7·7 per cent); ♀ *A. malaca* × ♂ *Phallusia* (68·5 per cent); ♀ *A. malaca* × ♂ *A. mentula* (83 per cent); ♀ *A. mentula* × ♂ *Phallusia* (11 per cent). These larvæ showed only maternal characters. The development-rate was always that characteristic of the maternal species. The larvæ did not metamorphose, probably due to culture conditions; but sometimes tail resorption occurred.

In the other cases, a tadpole stage was not reached. But gastrulation took place (apart from ♀ *A. mentula* × ♂ *Ciona*, where the eggs were only abnormally activated), and in a few cases some differentiation was observed (testal membrane, superficial pigment spots).

Cytological study of the material has not yet been made, so it is not possible to decide whether true hybrids were obtained or development was parthenogenetic. In most cases two polar bodies were extruded, and in some the conjugation of pronuclei was actually observed.

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Toxicity of Azo-Compounds and Other Substances to the Fruit Tree Red Spider Mite

LITTLE is known of the susceptibility to synthetic organic substances of the summer stages of the fruit tree red spider mite, *Metatetranychus ulmi* (Koch) (syn. *Paratetranychus pilosus* C. and F.), although recent work on this pest[1], and on the related mite *Tetranychus telarius* L.[2–5], has suggested that azobenzene is appreciably toxic. Consequently, we have recently examined in the laboratory, using *M. ulmi* as a test-organism, a series of compounds related to azobenzene, with the view of investigating the relation between toxicity and chemical structure.

A group of twenty-eight compounds was tested against the summer eggs on one hand and the adult female stage on the other; and, on arranging the compounds in order of toxicity, no well-defined parallelism was evident between the two series. There are, however, individual exceptions to this: notably, azobenzene, azoxybenzene and benzyl benzoate appear appreciably toxic to both stages, whereas 4-hydroxy-azobenzene, 4-amino-azobenzene, benzene-azo-*o*-cresol, diphenyl urea and diphenyl thiourea have little effect on either stage. The effect of substitution in the benzene nuclei has not yet been investigated in detail, but in the few cases examined such substitution products are less toxic than the parent compound. Thus, 4-amino-azobenzene, 4-hydroxy-azobenzene, 3 : 3′-dimethyl-azobenzene and benzene-azo-*o*-cresol are far less toxic than azobenzene, while 4 : 4′-diamino-diphenyl and benzaldehyde 2 : 4-dinitrophenylhydrazone are less toxic than diphenyl and benzaldehyde phenylhydrazone.

The azo-group does not appear to be essential to toxicity, since it may be replaced without loss by a variety of other atomic groupings. On the other hand, there is evidence that the precise nature of the grouping is of importance, and the accompanying table shows the toxic effect of compounds containing various alternative linkages between the two benzene nuclei.

EFFECT ON TOXICITY OF ALTERING THE BRIDGING GROUP BETWEEN TWO BENZENE NUCLEI

Toxicity	Alternative bridging group	
	Summer egg	Adult female
As toxic as azobenzene	—CO—O—CH_2— O ‖ —N=N— —SO_2— NO | —N— —NH—NH—	—CO—O—CH_2— O ‖ —N=N— —CH=N—NH—
Somewhat less toxic	—CH_2—NH—CH_2— —CH=CH— —CO—O— —CH_2—CH_2— —NH—	—CH_2—NH—CH_2— —NH—NH— —CO—CO—
Appreciably less toxic	—CH=CH—CO— —O— —CH=N—NH— —N=N—NH— No bridging group (diphenyl)	—CH=CH—CO— —O— —NH— —CO—O— —CH=CH— NO | —N— —CH_2—CH_2— —SO_2— —CH(OH)—CO—
Much less toxic	—CO—CO— —CH(OH)—CO— —NH—CO—NH— —NH—CS—NH—	No bridging group (diphenyl) —N=N—NH— —NH—CO—NH— —NH—CS—NH—

It will be noted that, under the conditions of our tests, azoxybenzene and benzyl benzoate were the only compounds with toxicity to both summer eggs and adult females comparable to that of azobenzene. Diphenyl sulphone was more toxic to the egg stage than any of the other compounds tested.

Further details of this and related work will be published elsewhere.

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Height of Meson Formation

In an earlier publication[1], it was reported that the intensity of cosmic rays appears to be closely related with the height of the 7·5-cm. mercury pressure-level. It was found that the correlation of cosmic-ray intensity at constant atmospheric pressure with the height of lower pressure-levels is rather low, though gradually increasing with height. When the 7·5-cm. pressure-level is chosen—the highest for which sufficient meteorological data were then available—this correlation reaches the value − 0·67. On the basis of the instability of the meson and by assuming that the bulk of the penetrating component originates at this presure-level, the value 18·6 km. was obtained for the mean range of mesons. In support of this hypothesis is the fact that if we take for the mass 180 m_e and for the average momentum of the mesons along their path down to sea-level the value 2,800 MeV./c. given by Rossi[2], then we have for the rest-life the value $2{\cdot}04 \times 10^{-6}$ sec., which agrees with the one generally accepted.

A study of the results obtained for the effect of ground temperature on cosmic-ray intensity in different parts of the world has now been made. It appears from this study that the mean value of the temperature coefficient α_1 obtained by using variations from day to day is about half the value, α_2, obtained by the use of variations from month to month. In addition to this it is known that α_1 shows a marked seasonal change[4].

Using upper-air data kindly supplied by the Meteorological Office, I have found that the difference between α_1 and α_2, as well as the seasonal change of α_1, for which so far as I know no explanation has been offered, can be accounted for as an effect of meson decay if we assume as before that mesons originate at the 7·5-cm. pressure-level, and take 18·6 km. for the mean range. The twelve-monthly variation in cosmic-ray intensity as obtained by Forbush[5] appears to be fairly well explained also by the same hypothesis.

We might therefore conclude from these results that the bulk of mesons is generated at the 7·5-cm. mercury pressure-level.

To see, however, what the results would be if a higher pressure-level had been assumed for the layer of meson formation, I have taken the 3-cm. pressure-level, the highest for which sufficient meteorological data are now available.

	α_1	α_2	12-monthly variation amplitude
Observed values . . .	−0·10%	−0·18%	1·43%
From 7·5 cm. Hg pressure-level .	−0·10	−0·24	1·65
" 3·0 " " " .	−0·15	−0·43	2·40

The accompanying table compares the results so obtained with the previous results.

It can be seen that the hypothesis of meson formation at the 3-cm. pressure-level leads to values which are roughly fifty per cent higher than those for the 7·5 cm. mercury pressure-level. To reconcile them with the experimental results, we should clearly have to take for the mean range of mesons a value of 28 km., a fifty per cent increase; but this value, together with the fact that in this case we should have to take for the average momentum of the mesons along their path[6] 2,100 MeV./c., would lead to a rest-life of $4{\cdot}0 \times 10^{-6}$ sec., a 100 per cent increase over the accepted value.

The conclusion appears, therefore, to be that the bulk of mesons is generated at, or little above, the 7·5-cm. pressure-level, at the height of the maximum of the Pfotzer curve for the intensity of the total radiation.

If the average layer for meson formation lies at that height, it follows that the intensity of the meson component should be decreasing at the 3-cm. mercury pressure-level (22 km.). On the other hand, the experimental result of Schein, Jesse and Wollan[7] shows that the hard component increases gradually up to the height of 2 cm. mercury pressure reached in their experiment. The two results, however, are not necessarily mutually exclusive if, as generally supposed, the mesons are formed by primary protons the penetrating power of which is not too different from that of the hard component. The intensity of the primary protons should increase gradually with height.

A complete account of this investigation is being sent to the Physical Society of London.

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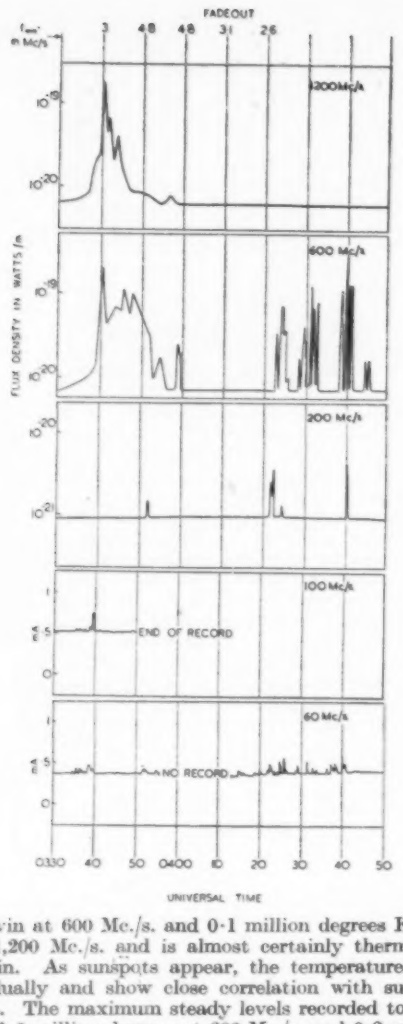
A Solar Noise Outburst at 600 Mc./s. and 1,200 Mc./s.

Simultaneous records of solar radiation at 200 Mc./s., 600 Mc./s. and 1,200 Mc./s. have been made at this laboratory for approximately two hours per day since August 18, 1947. In general, the 200 Mc./s. radiation is similar in character to that described by McCready, Pawsey and Payne-Scott[1], showing a considerable number of short bursts and an increase in general level as some sun-spots cross the meridian. The 600 and 1,200 Mc./s. records, on the other hand, show almost a complete absence of bursts, the level remaining fairly constant for any one day. The radiation received when the sun is almost free from sunspots corresponds to a solar black-body temperature of 0·5 million degrees



Kelvin at 600 Mc./s. and 0·1 million degrees Kelvin at 1,200 Mc./s. and is almost certainly thermal in origin. As sunspots appear, the temperatures rise gradually and show close correlation with sunspot area. The maximum steady levels recorded to date are 1·0 million degrees at 600 Mc./s. and 0·2 million degrees at 1,200 Mc./s. The absence of rapid changes in level suggests that the radiation is still thermal in character, and it is thought that the increase is due to the magnetic field of the sunspots raising parts of the effective radiating shells into the corona[2], which is at a temperature of at least 1 million degrees.

An isolated exception to the above general behaviour occurred on October 4, when there was an outburst of radiation on 600 Mc./s. and 1,200 Mc./s. Both levels increased to thirty times their normal value and remained high for approximately ten minutes, showing the typical characteristics of an outburst. A radio fadeout was reported by the Mount Stromlo ionospheric recording station at the same time. On 600 Mc./s. another disturbed period characterized by a series of bursts began twenty minutes later. The 200 Mc./s. record was that of a quiet sun with only a few isolated bursts. For part of this period records are also available on 60 Mc./s. and 100 Mc./s. On these frequencies no outburst occurred, but a group of bursts coincided with the commencement of the outburst at the higher frequencies. The records are shown in the accompanying figure.

The 200 Mc./s., 600 Mc./s. and 1,200 Mc./s. levels are plotted in terms of flux density. If this were done for the 60 Mc./s. and 100 Mc./s. records, even small bursts would appear as large increases in flux density and a false emphasis of relative solar activity would result. Consequently the records have been left in the arbitrary scale of receiver output current, and indicate in this instance mild solar activity at 60 Mc./s. and 100 Mc./s.

The absence of an outburst on 200 Mc./s. was not due to an instrumental defect, because the aerial was directed away from the sun several times during the period and gave a consistent reduction in receiver output. This indicated that a definite and steady noise contribution was being obtained from the sun.

It is of interest to note that the only other solar disturbance recorded for frequencies above 200 Mc./s. is a 480 Mc./s. storm reported by Reber[3], which also coincided closely with a radio fadeout[4]. In both Reber's case and ours, the occurrence of the fadeout may be taken as fairly certain evidence that a chromospheric flare occurred at the same time. Allen[5] and Appleton and Hey[6], observing at 200 Mc./s. and 64 Mc./s. (4·7 metres) respectively, have noted that some flares are accompanied by solar noise outbursts. As the noise radiation at 600 Mc./s. and 1,200 Mc./s. is believed to arise at lower levels in the sun's atmosphere, a closer correlation between outbursts and flares might be expected on these higher frequencies.

This work is part of the research programme of the Radiophysics Laboratory, Commonwealth Council for Scientific and Industrial Research.

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Jan. 13.

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Cosmic Rays and the Magnetic Field of the Moon

In a recent communication, S. Chapman[1] has calculated, on the basis of the theory of proportionality between magnetic moment and angular momentum developed recently by P. M. S. Blackett[2], that the ratio M_M/M_E between the magnetic dipole moment of the moon and that of the earth is 1/38,400. It may be readily shown that if this result is correct the magnetic field of the moon can only affect particles of primary cosmic radiation of very small energy, which are able to reach the earth only in the immediate vicinity of the geomagnetic poles. In fact, we have[3]

$$M_M/M_E = (D_M/R_E)^2 (r_E/r_M)^3,$$

which on replacing M_M/M_E by Chapman's value, taking for the ratio D_M/R_E (D_M, distance from the

earth to the moon; R_E, radius of the earth) its known value, and using for r_M the limiting value $r_M = 0{\cdot}414$, gives $r_E = 0{\cdot}05$ millistörmers, or approximately 0·1 MeV. (1 MeV. = 10^6 eV.) if the primary particles are protons, 0·3 MeV. if electrons.

It is therefore clear that the present difficulties[4] concerning the origin of the diurnal and seasonal variations of the intensity of cosmic radiation cannot be traced to a possible magnetic field of the moon of the magnitude predicted by Blackett's theory. It is also obvious from the foregoing discussion that scarcely any measurable effects on cosmic radiation can be expected to arise from the possible existence of such a field.

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[1] *Nature*, **160**, 395 (1947).
[2] *Nature*, **159**, 658 (1947).
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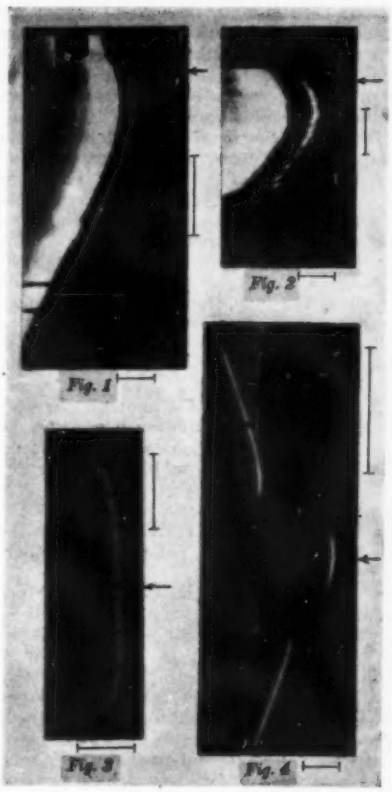
Initiation of High Explosives

In several communications in *Nature*[1–4], the spread of the detonation wave near the point of initiation has been discussed. During 1943–46, we carried out similar experiments at the University of Saskatchewan (sponsored by the National Research Council of Canada). Since our conclusions differ in several points from those in the above-mentioned letters, it may perhaps be of interest to summarize some of our results[5].

We used a rotating mirror camera with an image speed of 2,000 m./sec., which is twenty times that used by Weibull[1]. With this high speed it is possible to study changes in the detonation waves within much smaller intervals of space and time than has been done by Weibull and others.

Contrary to the results of Weibull[1], and of Mitchell and Paterson[3], we found that in all cases investigated by us the apparent centre of the spherical detonation wave is some distance (initiation distance) *in front of* the detonator. Fig. 1 shows a rotating mirror photograph of the detonation of three cylindrical cyclonite pellets (containing 9 per cent beeswax) of density 1·55 in tandem, initiated by a No. 6 detonator in contact with the centre of (but not embedded in) the top surface. The time axis is horizontal; the detonation proceeds from top to bottom. The explosive was contained in a wide glass tube filled with propane, which served to suppress the shock-wave luminosity. The thin track to the right is the detonation track; the broad and bright track to the left is due to the impact of the shock wave on the glass wall. Fig. 2 gives a similar picture for a pressed T.N.T. pellet of 32 mm. diameter and 22 mm. height, initiated by a No. 8 detonator (as used by Weibull). The important feature of these tracks is the bending back at the top (hook effect), which indicates that the centre of the spherical wave is *below* the top surface in spite of the fact that the initiation occurred at the top surface. It should be emphasized that the same effect was found consistently in many shots of this type, not only for cyclonite and T.N.T., but also for tetryl and NENO [6] (the latter both pressed and cast). The initiation distance is approximately constant for a given explosive in different shots. It varies from about 2 mm. for tetryl to 7 mm. for T.N.T. A positive initiation distance has also been found for liquid explosives (super-cooled NENO, and DINA [6] at about 70° C.) and even for lead azide (the latter initiated in a glass tube by a hot wire above the top surface).



HORIZONTAL LINES UNDER PHOTOGRAPHS INDICATE TIME OF 1 MICROSEC. VERTICAL LINES INDICATE LENGTH OF 1 CM. AT CHARGE; ARROWS INDICATE POINTS OF INITIATION. BLACK LINES THROUGH DETONATION TRACKS ARE IDENTIFICATION MARKS

When the explosive is initiated by a detonator placed near the surface that faces the camera rather than in the centre of the top surface of the cylindrical pellets, no hook effect is observed, in agreement with expectation. Instead, a dark space is observed; that is, for a distance equal to the initiation distance, no detonation luminosity is found.

Further evidence was obtained by the detonation of hemicylindrical charges initiated in the centre of the flat face, the axis of the cylinder being horizontal. If the spherical detonation wave originated at the point of contact of the detonator, it would reach all points along the intersection of a vertical plane with the surface of the cylinder at the same time. Actually, as Fig. 3 shows for cyclonite (density 1·5), the observed traces are not straight but bent back at top and bottom. This is again in agreement with the assumption of an initiation distance.

It appears to us that the interpretation of these results can only be that the detonator sets up a low-order detonation, which, after travelling for a distance, changes over within a rather small region of the wave front to high-order detonation. The low-order detonation described here seems to be of a fundamentally different type from the low-order

detonations discussed by Shepherd[2] and by Jones and Mitchell[4] which we have also observed. While in the latter a change to high-order detonation occurs more or less uniformly and simultaneously over the whole wave front, in the former the transformation takes place in a small part of the wave front only, which forms the centre of the high-order spherical detonation wave. Moreover, this new type of low-order detonation appears even for rather strong initiation and never extends over large distances. Only by reducing the strength of the initiation (by interposing sheets of paper between detonator and high explosive) to a point very close to the limit where failure occurs have we been able to increase the length of the initiation distance by a factor of two or three. From our experience it would appear that this type of low-order detonation is a necessary preliminary in each individual initiation process.

In T.N.T. the situation is apparently more complicated, since in a number of photographs we found a slowing down of the high-order detonation, leading either to a fading out, or, at a certain place, to a second speeding up to the final high-order detonation. This second transformation is of the type observed by Shepherd[2] and by Jones and Mitchell[4]. The peculiar behaviour of T.N.T. may be due to the fact that the T.N.T. used in the pellets had a rather large particle size (about 1 mm.).

Very striking results confirming the peculiar behaviour of the new type of low-order detonations were obtained when thin flat pellets of a thickness of a few millimetres (that is, of the order of the initiation distance) were initiated in the centre of one flat face while the other flat face was facing the camera. Fig. 4 shows a photograph obtained with cyclonite. Instead of one single track, there are three apparently unrelated partial tracks. They represent three different high-order detonations produced at different points of one and the same pellet and at slightly different times by one and the same initiation. It appears that the initial low-order detonation changes to high-order at different places and times. In larger charges the first formed detonation wave will soon spread and leave no explosive for the others. But in sufficiently thin charges the different waves can be observed, as in Fig. 4. By putting a steel plate behind the thin pellets, we have checked that the different tracks are not due to different fragments of the detonator.

From the width of the track in Fig. 1 and similar photographs, an upper limit for the duration of the luminosity may be estimated. It is 0·05 microsec. (only a sixth of the limit given by Mitchell and Paterson). In the case of cyclonite it was found from other evidence that the actual value is close to this limit.

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[2] Shepherd, W. C. F., *Nature*, **160**, 92 (1947).
[3] Mitchell, D., and Paterson, S., *Nature*, **160**, 438 (1947).
[4] Jones, E., and Mitchell, D., *Nature*, **161**, 98 (1948).
[5] More details may be found in our reports on Project XR–84, copies of which are obtainable on application from the National Research Council of Canada, Ottawa, Ont.
[6] NENO and DINA are war-time abbreviations for bis-nitroxyethyl-nitrooxamide and bis-nitroxyethylnitramide, see Wright, G. F., *et al.*, *Can. J. Res.* (Jan. 1948).

Principle of a Counter-streaming Centrifuge for the Separation of Particles of Different Sizes

When a liquid containing suspended particles of uniform density streams through a conical tube, the velocity of the particles is greatest at the apex of the cone and decreases in the direction of the base. If the tube is placed in a centrifuge with the apex pointed away from the centre of rotation, in the direction of which the liquid is made to flow, the particles acquire, in addition to the velocity due to the liquid stream, a velocity in the opposite direction owing to the centrifugal effect. If Z is the distance between the apex and the centre of rotation, R the radius of the cone at the distance L from the apex, V the volume of liquid passing across any section of the tube in unit time, and x the distance from the centre of rotation, then the streaming velocity f over any cross-section of the tube is

$$f = \frac{V}{\pi(R/L^2)\,(Z-x)^2}.$$

The velocity of the particles in the direction away from the centre of rotation, however, increases linearly with the distance from the latter. In a certain cross-section (e) the two velocities are equal for a given particle size. Particles of this size situated centripetally from e are transported in the centrifugal direction and vice versa. Thus, when dynamic equilibrium has been attained, they have been accumulated in a very short section of the tube. Other particles are similarly accumulated in sections characteristic of their sizes; the smaller their radii (r), the nearer the centre of rotation are their planes of equilibrium. The distribution of these planes along the radius of rotation is derived from Stokes' law and the above expression for the streaming velocity:

$$r = \frac{3}{2\pi n} \cdot \sqrt{\frac{\eta \cdot V}{2\pi(S-S')}} \cdot \frac{1}{\sqrt{X}\,.\,(R/L)\,(Z-x)},$$

where n is number of revolutions per min., η is viscosity of liquid, S is density of particles, S' is density of suspension medium. For $x = Z/3$, r has a minimum value:

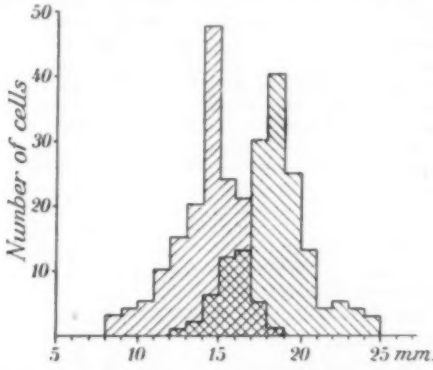
$$r_{\min.} = \frac{3}{2\pi n} \cdot \sqrt{\frac{\eta \cdot V}{2\pi(S-S')}} \cdot \frac{1}{\frac{2}{3} \cdot \frac{R}{L} Z \sqrt{Z/3}}.$$

This implies that only particles with radii smaller than $r_{\min.}$ can pass with the liquid stream through the tube. This minimum value, characteristic of each tube, is dependent only on R/L (that is, the apical angle of the cone), other things being equal.

As soon, however, as particles accumulate in a centripetal segment of the tube, the centrifugal part of which contains a less dense suspension or pure liquid, the heavier layer breaks up, forming a centrifugally directed current. Also particles with radii smaller than $r_{\min.}$ are carried by this current and caught in a kind of circuit current formed between the chief and the centrifugally directed currents. To avoid interactions between these two currents, that flowing centrifugally is conducted outside the tube through a side channel, the particles being introduced again near the apex and thus made to pass through the separating tube several times. Because of the

influence of rotation on the moving liquid and particles, the centripetal part of the tube should be turned towards the direction of rotation. If two tubes with suitable chosen values of R/L are coupled in series so that the tube with a larger $r_{min.}$ is first passed by the particles, any desired fraction of particles can be removed from the suspension.

In work with large particles having a high density compared to that of the liquid, and a low liquid viscosity, a necessary condition is that the influence of gravity on the particles is eliminated. This can be realized by rotating the centrifuge in the vertical plane.



BAKER'S YEAST CELLS SUSPENDED IN TAP WATER AND CENTRIFUGED FOR 60 MINUTES. ABSCISSA, GREATEST DIAMETER OF THE CELLS (× 2,350). SHADED AREAS SHOW NUMBERS OF LARGER CELLS RETAINED IN THE SEPARATING TUBE AND IN A FOLLOWING TUBE RESPECTIVELY; THE OVERLAPPING WILL DIMINISH ON PROLONGED CENTRIFUGATION

A trial centrifuge has been constructed on these principles and is at present being employed for the fractionation of yeast cells (see graph) and other biological material. A detailed description will shortly be published elsewhere.

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Electrokinetic Potential and Surface Structure of Barium Sulphate

WHILE there are many investigations on the influence of electrolytes on the electrokinetic or ζ-potential of solids, very few investigators have considered the relation between the ζ-potential and the structure and composition of the solid itself. This is partly due to the fact that in many systems the potential-determining ions are foreign to the solid.

We are at present investigating the ζ-potential of sparingly soluble ionic solids such as barium sulphate against their saturated solution by the streaming potential method. In this case, the potential-determining ions originate from the solid. Precipitated barium sulphate is unsuitable for investigation, because the validity of the electrokinetic equations is limited to systems in which the diameter of the 'pores' of a plug is greater than the thickness of the electric double layer. We therefore prepared larger crystals (up to 2 mm.)—which could be ground afterwards to any desired size—by recrystallizing barium sulphate from hot concentrated sulphuric acid and subsequent ignition. The following results are typical:

	ζ in mV.
Recrystallized barium sulphate, sample 1	+ 24·2
Recrystallized barium sulphate, sample 3	+ 25·0; 24·3
Recrystallized barium sulphate, sample 4	+ 26·6; 27·1
Natural barite, sample *B*, ignited	+ 5·4; 5·3
Natural barite, sample *C*, ignited	+ 8·4

In spite of the fact that during preparation of recrystallized barium sulphate there was always an excess of sulphate ion, the potential is *positive* and well reproducible within 1 mV. for each sample. The ignition temperature (500–1,000° C.) has no influence on the potential. Most electrolytes change the potential *reversibly* at room temperature; barium salts increase it, sulphates decrease it; but when, after treatment with the electrolyte solution, the potential is then measured against a saturated barium sulphate solution, the original value is always obtained. This value must therefore be regarded as a property of the sample. This behaviour is shown both by recrystallized barium sulphate and natural barite.

There is, however, a striking difference between the high potential of recrystallized barium sulphate and the much lower potential of natural barite. Spectroscopic analysis of our samples revealed that natural barite contains strontium and traces of calcium as impurities. However, these impurities cannot be responsible for the difference in potential. We incorporated such impurities into the recrystallized barium sulphate (during recrystallization); but, as a result, the potential was slightly increased, never decreased. Moreover, when natural barite is recrystallized from sulphuric acid, a high potential (27 mV.) is obtained.

These and similar observations, which will be discussed in more detail elsewhere, lead us to the conclusion that the difference in potential between recrystallized barium sulphate and natural barite is not due to a difference in composition. The most likely cause is a difference in structure (geometrical or otherwise) of the surface. Natural barite, even after crushing, has even crystal surfaces, whereas recrystallized barium sulphate has very irregular surfaces. This is shown by an investigation in an optical as well as in an electron microscope, for the latter of which we are indebted to Dr. A. L. G. Rees and Mr. A. J. Hodge, of the Division of Industrial Chemistry of the Council for Scientific and Industrial Research. It is likely that the field of force is less well balanced in an irregular surface than in an even one.

Bikerman[1] suggested that the ζ-potential of a rough surface should be different from that of a smooth one for purely geometrical reasons. However, the distortion of the field of force in the surface as a factor influencing the electric potential at a surface is a somewhat unfamiliar concept in the field of electrokinetics. Nevertheless, besides our own observations, there are several findings of other investigators[2,3] which suggest that the ζ-potential of a crystalline solid is not solely determined by the composition of the system.

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[1] Bikerman, *J. Chem. Phys.*, **9**, 88 (1941).
[2] Kruyt and Ruyssen, *Proc. Akad. Wetensch. Amsterdam*, **37**, 498 (1934).
[3] Wood, *J. Amer. Chem. Soc.*, **68**, 437 (1946).

Chemical Effects of Ionizing Radiations

In 1944 it was suggested[1] that the primary net process in the action of penetrating radiations (γ-rays, X-rays, etc.) on the water molecule consists in its splitting in the following way:

$$H_2O \rightarrow OH + H,$$

which presumably takes place by way of the formation of H_2O^+ and H_2O^-. All the known chemical effects in aqueous solutions can be interpreted on this basis[1,2], which furthermore permits an adequate description of the biological effects of radiations[3,4]. Recently, Dainton[5] found that acrylonitrile in dilute aqueous solution on irradiation by X-rays or γ-rays shows polymerization, which he attributed to the action of primarily formed hydroxyl radicals (according to the above scheme) in view of the fact that these radicals are known to initiate polymerizations[6].

We have now succeeded in demonstrating the mode of action of penetrating radiations in aqueous solutions by investigating the reaction products formed by irradiating some simple organic substances such as benzene and benzoic acid in dilute aqueous systems. If hydroxyl radicals are formed primarily, it should be possible to isolate some of the corresponding substances containing OH groups, that is, products of hydroxylation. This, indeed, proved to be the case.

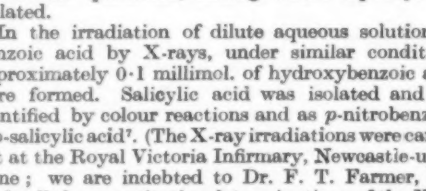
Benzene, suspended in water from which oxygen had been carefully excluded, was irradiated by X-rays by bringing it close to the target of a 200-kV. tube, and a dose of the order of 10^6 r. units was given. This resulted in about 0·1 millimol. of phenol being formed, which was identified as the tribromo derivative. A number of other substances were also found in smaller quantities, among which diphenyl was isolated.

In the irradiation of dilute aqueous solutions of benzoic acid by X-rays, under similar conditions, approximately 0·1 millimol. of hydroxybenzoic acids were formed. Salicylic acid was isolated and was identified by colour reactions and as *p*-nitrobenzene-azo-salicylic acid[7]. (The X-ray irradiations were carried out at the Royal Victoria Infirmary, Newcastle-upon-Tyne; we are indebted to Dr. F. T. Farmer, who made all the quantitative determinations of the X-ray dosage.)

We have also carried out similar experiments using a neutron–γ-ray source (corresponding to 1 gm. of radium mixed with beryllium powder). With this source, benzene gave, in addition to the products mentioned above, catechol and products originating from the opening of the benzene ring. This difference is presumably due to the higher local concentration of radical produced by the recoil protons (from the neutrons).

In all these cases the total yield of the hydroxylated reaction products depends on the *p*H of the solutions.

The above results suggest the following sequence of reactions in the case of benzene and benzoic acid:



In the case of benzene, the intermediate formation of free phenyl radicals is suggested by the appearance of small amounts of diphenyl among the reaction products. The dehydrogenation to the phenyl radical may be due to a reaction with the hydroxyl radical or possibly with hydrogen atoms. Experiments to decide this are in progress.

The results indicate that: (i) Hydroxyl radicals are formed by the action of radiations on aqueous systems, since the reaction products found are the same as those obtained by the action of hydroxyl radicals produced chemically (for example, by the system $H_2O_2 - Fe^{II}$ salt). (ii) The oxidation products are very similar to those obtained in the biological oxidation of these substances, which suggests that hydroxyl radicals may play an important part in certain biological oxidations[8].

We are indebted to Prof. F. A. Paneth for permission to carry out the neutron experiments in the Londonderry Laboratory for Radiochemistry at Durham.

A full account of this work will be published elsewhere.

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Feb. 6.

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[2] Cf. Lea, E. D., "Actions of Radiations on Living Cells", 47 (Cambridge University Press, 1946).
[3] Weiss, J., *Nature*, **157**, 584 (1946).
[4] Weiss, J., *Trans. Farad. Soc.*, **43**, 314 (1947).
[5] Dainton, F. S., *Nature*, **160**, 268 (1947).
[6] Cf. Evans, M. G., *et al.*, *Trans. Farad. Soc.*, **42**, 668, 675 (1946).
[7] Cf. Beilstein, 4th ed., **18**, 247.
[8] Cf. Haber, F., and Willstätter, R., *Ber.*, **64**, 2844 (1931).

A Coefficient of Viscous Extension

While working on a generalized theory on straining of amorphous or quasi-amorphous solids, it became clear that one could include the straining of viscous fluids by means of a suitable stress-strain parameter λ which I call a 'coefficient of viscous extension' related to the 'coefficient of viscous shear' usually called[1] the coefficient of viscosity μ. In this communication only the flow strain component of a deformed substance[2] is considered, so that the elastic and plastic components[2] are neglected and, further, only isotropic substances are discussed.

An infinitesimal angle γ_{ij} of shear 'slide' has twice the arithmetical value of the normal strain ϵ_{ij} in the 'auxiliary' plane at 45° to the planes on which the shear stress S_{ij} operates[3,4]. Hence, differentiating with respect to time t and using the coefficient of viscosity gives

$$2\frac{\partial \epsilon_{ij}}{\partial t} = \frac{\partial \gamma_{ij}}{\partial t} = \frac{S_{ij}}{\mu}. \qquad (1)$$

But the normal strain ϵ_{ij} due to shear can be regarded as due to the 'partial' strains ϵ_{ij}, ϵ_{ji} and transverse contraction ratio q[1,2,3]. But the partial strain ϵ_{ji} is equal to but of opposite sign to ϵ_{ij}, so that

$$\epsilon_{ij} = (1 + q)\epsilon_{ij}. \qquad (2)$$

The normal stress T_{ij} is 'auxiliary' to, and of the same arithmetical value as, the shear stress S_{ij} if the

displacements are to be single-valued[2]. Hence, if we *define*

$$T_{ij} = \lambda \frac{\partial \varepsilon_{ij}}{\partial t}, \qquad (3)$$

then from (1), (2), (3)

$$\lambda = 2(1 + q)\mu. \qquad (4)$$

This 'coefficient of viscous extension' allows one to synthesize the Navier–Stokes viscous fluid theory with a theory on the straining of solids. The coefficient λ in the flow case is analogous to Young's modulus in the static strain case. However, it should be noted that in (1) and (3) only *time-rates of straining* occur, so that my theory on strains of any magnitude can be used to give a general theory on straining that incorporates flow in solids and viscous fluids. As presented here, the coefficient of viscous extension λ is a non-constant tangent modulus if the substance is quasi-viscous[6]. The transverse contraction ratio q will have the value $\frac{1}{2}$ in solids as well as liquids if volume changes do not occur. However, caution is necessary in view of the static 'plastic' transverse contraction ratio value 0·36 for duralumin[7] found by me; this has been checked with a photo-grid and a specially designed optical extensometer[8]. Further, the same value was found for changes in thickness of the tensile specimen.

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Jan. 15.

[1] Swainger, K. H. (communicated to *Phil. Mag.*, Dec. 27).
[2] Swainger, K. H. (communicated to *Phil. Mag.*, Oct. 14).
[3] Swainger, K. H., *Phil. Mag.*, (7), **38**, 422 (1947).
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[5] Swainger, K. H., *Phil. Mag.*, (7), **36**, 443 (1945).
[6] Houwink, R., and Burgers, W. G., "Elasticity, Plasticity and Structure of Matter", 10 (Camb. Univ. Press, 1940).
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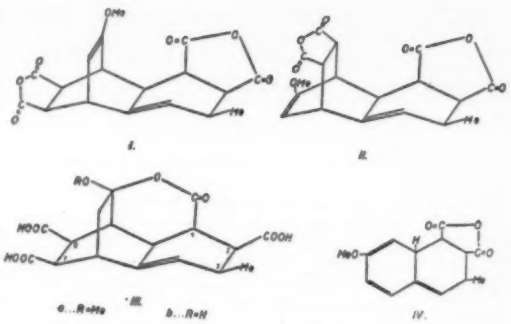
Addition of Maleic Anhydride to Anethole

ONE of us[1] has earlier obtained a small amount of a crystalline compound (m.p. 241°, decomp.) of anethole with two moles of maleic anhydride, the main bulk of the reaction product being a heteropolymer[1,2,3]. We found that, if a small amount of dimethylaniline is added, the formation of the heteropolymer product is prevented and the yield of the crystalline adduct was as high as 60 per cent. We have confirmed the structure previously proposed[1] and our work led further to the determination of the steric configuration of the compound.

If we assume an endo-*cis* type addition[4] and start from anethole, which may be supposed to be a *trans* anethole, then the formation of four possible stereoisomers (that is, two racemates) could be expected, namely, I, II and their respective antipodes. The properties of our compound agree with those expected from I.

The following reactions may be cited in favour of I and excluding II. Mild alkaline hydrolysis leads to III (*a*); if the hydrolysis is more energetic, III (*b*) is obtained. The ultra-violet absorption spectrum of III (*b*) does not show the characteristic band of a



carbonyl group. This acid forms heterocyclic compounds with hydroxylamine as well as with phenylhydrazine; hence one of the carboxyl groups participates also in the condensation. When III (*b*) was boiled with 5 *N* hydrochloric acid, the carboxyl groups in positions 1 and 8 became a *trans* position and an isomeric *trans* keto-acid was obtained containing a free carbonyl group, the presence of which was revealed by the ready formation of a regular oxime and by its absorption spectrum. The olefinic bond of III (*b*), which is resistant to catalytic hydrogenation, was confirmed by the addition of two hydroxyl groups. If compound I is heated with sulphur to 300°, it decomposes with formation of maleic anhydride and the anhydride of 3-methyl-7-methoxy-naphthalene-1 : 2-dicarboxylic acid.

The formation of the compound I makes it clear that, from the point of view of diene synthesis, anethole behaves as a conjugated tetraene, that is, it gives first with one mole of maleic anhydride the labile primary compound IV, which in turn reacts instantaneously with another mole of maleic anhydride, forming the stable end-product I.

Our observation seems to be of interest from the following two points of view: (1) So far as we know, this is the first *proved* example of the possibility of disturbing the aromatic character of a mononuclear system through a Diels–Alder reaction. Such a process leading to a compound of analogous structure to I had been suggested but later rejected by Wagner-Jauregg[5] in the case of the Diels – Alder reaction of *as.* diphenylethylene. This structure has, however, recently been accepted by Bergmann and co-workers[6], but was not established by them in a decisive manner. (2) From our results it is probable that the Diels – Alder reaction of some styrene derivatives is initiated by the heteropolar resonance form of the partners[7].

The full details of these investigations will be published elsewhere.

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Aug. 12.

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OSCILLOGRAPHIC ANALYSIS OF THE NON-ACOUSTIC FUNCTIONS OF THE VERTEBRATE EAR

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THE non-acoustic functions of the vertebrate ear are localized in the semi-circular canals with their ampullary end organs, and the utriculus, the anterior or uppermost of the two or three otolith organs of the vestibulum[1]. The function of the semi-circular canals is restricted to the perception of angular accelerations occurring during rotational movements, chiefly at their onset and cessation. The utriculus, on the other hand, is held responsible for the perception of changes in position within the gravitational field, of linear accelerations brought about by straight-line movements, and of the centrifugal effect during relatively fast rotations.

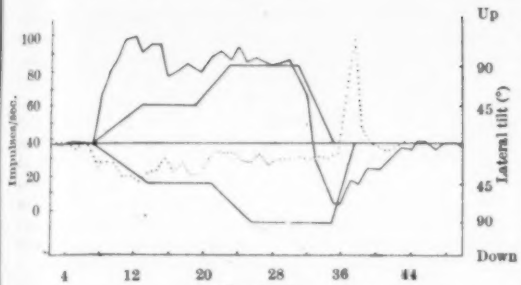
Until recently, analysis of the equilibrium function of the labyrinth was based entirely on evidence obtained by elimination experiments in which operative removal of the organ as a whole or in parts or transection of the various branches of the eighth nerve was followed, in the surviving animal, by observation of the equilibrium reflexes of head, eyes, or limbs, and their comparison with the normal labyrinthine reflexes. With the development of Adrian's technique of oscillographic recording of the electrical activity of sense organs arose the possibility of the direct analysis of the equilibrium function of the labyrinth. The first attempts in this field were reported by Ashcroft and Hallpike[2], and Ross[3] on the frog, and by Lowenstein and Sand[4] on the dogfish. Thanks to the ideal conditions offered by the cartilagenous nature of the elasmobranch cranium, it was found possible in the intact dogfish to record directly from the nerve-branch supplying the ampulla of the horizontal semi-circular canal. This led to the discovery that the intrinsic mechanism of canal function is based upon a background of resting discharge the frequency of which is, in the horizontal canal, increased by homolateral, and decreased by contralateral angular acceleration in the plane of the canal, with corresponding post-rotatory after-effects in response to deceleration. This mechanism clearly provides the means by which a single ampullary rotation-receptor unit can signal to the centre opposite phases of angular acceleration and deceleration in a given plane. The corresponding ampullæ on both sides of the head work antagonistically, and the reflex responses in the intact animal depend on the balance of the afferent discharges from left and right labyrinths.

Apart from serving as a background for this two-directional response, the resting discharge was also claimed to provide a continuous source of tonus supply to the musculature, and this could afterwards be demonstrated by means of elimination experiments carried out on the horizontal canal of the pike[5]. The analysis of the function of the ampullary end-organs in the two vertical canals which proved impracticable in the intact animal was carried out on the surviving preparation of the labyrinth in the isolated cranium of the ray[6]. As a result, a complete picture of the integrated action of all six semi-circular canals during rotation about the three primary axes was obtained, which could be correlated with the known eye muscle reflexes normally evoked by these rotations. In contrast to the horizontal canals, which respond to angular accelerations in or near their plane only, each vertical canal responds to rotation about all three primary axes. They are laterally synergic on rotation about the longitudinal axis, transversely synergic on rotation about the transverse axis, and react with reduced sensitivity to rotations about the vertical axis, when they are found to be diagonally synergic. An analysis of the integrated activity of the six semi-circular canals in relation to the known eye muscle reflexes evoked by rotational stimuli yielded a consistent picture, which furnished evidence for the vestibular origin of the simultaneous contraction of pairs of antagonistic eye muscles occurring during labyrinthine eye nystagmus. These have been recorded myographically in the rabbit by Lorente de Nó[7], who described them as pivoting reactions, postulating their central nervous origin.

In a consequent quantitative study of the mechanism of canal function carried out on the horizontal semi-circular canal of the isolated labyrinth of the ray[8], single-fibre discharges were recorded in response to different intensities of angular acceleration and during rotations at constant angular velocities. During uniform angular acceleration the impulse frequency increases and decreases in a linear manner proportional to the acceleration and deceleration. The threshold acceleration was found to be as low as 3°/sec./sec., a fact which suggests that high turntable speeds often used in equilibrium experiments and in clinical tests may involve angular accelerations representing considerable overstimulation of the sense organ. During prolonged rotation at constant speed, the frequency of discharge, after reaching a maximum or minimum during the initial acceleration, gradually returns to the value of the resting discharge. It is interesting to note that the maximum time of 20–30 sec. taken for this return is the same as that described by Steinhausen[9] in his experiments on the physical properties of the living cupula terminalis of the semi-circular canals in the pike. It also agrees with the duration of post-rotatory after-effects, for example, nystagmus and vertigo, observed in all vertebrates, including man. Results on the human subject obtained by Jonkees and Groen (Utrecht), according to private intimation by the authors, also bear out this fundamental similarity in time relations. All this fully justifies the interpretation of reflexes to angular acceleration in terms of the elastic properties of the cupula, and makes unnecessary the assumption of their central elaboration.

The analysis of the mode of function of the vestibular receptor for gravitational stimuli and linear accelerations, namely, the otolith organ in the recessus utriculi, had been held up by the War, but has now been attempted in collaboration with my colleague, Mr. T. D. M. Roberts. The work was carried out at the laboratory of the Marine Biological Association at Plymouth during the summer of 1947, with the aid of a Royal Society grant from the Parliamentary Grant-in-aid of Scientific Investigations, and with the privilege of the use of the British Association Table at the Plymouth Laboratory. The results to be reviewed in this communication will be the subject of a fully documented publication elsewhere.

The method used was similar to that described in the publications on the function of the semi-circular canals. Considerable technical difficulties had, however, to be overcome in the attempt to record from



Horizontal line across graph indicates basic discharge level

RESPONSES TO LATERAL TILT FROM A 2–3 FIBRE PREPARATION FROM THE UTRICULUS OF THE ISOLATED LABYRINTH OF THE RAY. THE STRAIGHT LINES TRACE THE COURSE AND TIME RELATION OF LATERAL UP AND DOWN DISPLACEMENTS FROM THE NORMAL. THE CURVES SHOW THE COURSE OF THE RESPONSE IN IMPULSES PER SEC. AS DESCRIBED IN THE TEXT. ——— RESPONSE TO UPWARDS TILT, ... RESPONSE TO DOWNWARDS TILT. THE PREPARATION SHOWED A BASIC DISCHARGE FREQUENCY OF 38 IMPULSES/SEC. WHEN AT REST IN THE NORMAL POSITION

the branch of the eighth nerve supplying the macula utriculi. In a ray of a wing span of more than twenty inches this is only 5–6 mm. long, measured from its origin at the brain to the final terminations of its fibres in the macula, and of this about 2 mm. only were suitable for electrical pick-up. By carefully peeling off minute strands from the nerve fan on the lateral wall of the utriculus, preparations were made from which analysable records could be obtained of the activity of single sense endings or of groups of small numbers of independently firing units.

Again, as in the case of the semi-circular canal, it was found that, when at rest in the normal orientation in space, the sense endings in the macula utriculi fire off a continuous stream of low-frequency impulses, between 6 and 12 per sec. at 20° C. The frequency level of this discharge remains constant unless the spatial position of the preparation is changed. This could be achieved by slowly rotating the preparation and electrode system fixed in a holder about axes corresponding to the transverse and longitudinal body axes. By means of a clamping device, the preparation could be held stationary in any desired position in space. The accompanying figure shows the result of tilting a two to three unit preparation around the longitudinal axis to positions of 45° and 90° lateral tilt homolateral side upwards and downwards. It will be seen that during the rotation into the new position the discharge frequency changes, increasing during upwards and decreasing during downwards tilt. After the preparation becomes stationary in the 45° and 90° positions a certain return of the discharge frequency towards the level characteristic for the normal position occurs; but after a few seconds the frequency becomes stabilized significantly above or below the 'normal' level. During the return movement a drastic change in the discharge frequency takes place in a sense opposite to that brought about by the initial displacement from the normal. Back in the normal position the discharge returns to the original frequency level. If the same preparation is now rotated about the transverse axis to positions 45° and 90° nose up or down it is found to respond with equal sensitivity to this displacement. The preparation from which the curves shown in the diagram were derived yielded similar responses on rotation about the transverse axis, with an increased frequency level in nose up, and a decrease in frequency in nose down positions, and correspondingly similar behaviour during the rotation to and from the out-of-level positions.

Responses from preparations that yielded analysable records can be classified into four groups, namely, showing increased discharge (*a*) on side up and nose up, (*b*) on side up and nose down, (*c*) on side down and nose down, (*d*) on side down and nose up, while correspondingly reversed displacements bring about a decrease in the discharge frequency. We have not found preparations without a resting discharge or preparations which were capable of responding by either increase or decrease only. We also failed to find preparations which were confined to responding to displacements about either the longitudinal or transverse axis only; and the fact that the two-axis response with its diagonal plane of maximum sensitivity could be demonstrated in a single-unit preparation counters the suspicion that in few-fibre preparations this might have been due to recruitment from two different types of receptors, an assumption which could not be completely refuted on any other grounds.

The present results are based on the evidence from twelve successful preparations with the following numerical distribution of types: Type *a* : 2; *b* : 2; *c* : 1; *d* : 1; of the remaining six preparations, in which for technical reasons the response to displacement about the longitudinal axis could not be recorded, two showed an increase of discharge on nose up, and four on nose down displacement. As all these preparations were obtained from a relatively restricted area of the utricular macula, the conclusion appears unavoidable that the four types of sense endings are dispersed over the whole macula. Their typical mode of reaction will, in this case, have to be ascribed to their minute distribution in or around deformable structures intervening between macula and otolith membrane. We hope that a study of the microscopic pattern of the macula which we are about to carry out will throw further light on this question.

Experiments in which utriculus preparations were subjected to linear accelerations showed repeatable responses of fairly low threshold to straight-line movements in all three planes of space. This result is of special interest in view of the fact that no reliable reflex responses to linear accelerations have so far been detected in fishes[10].

It can thus be stated that the otolith organ of the utriculus is sensitive to positional changes about any horizontal axis, longitudinal, transverse and intermediary. In contrast to the semi-circular canals which respond to angular accelerations only, the otolith organ responds during tilting to angular accelerations and to rotation with constant speed; furthermore, it shows lasting responses to prolonged out-of-level positions. Its ready response to linear acceleration during straight-line translation makes it a certainty that it will also respond to centrifugal effects. The localization of all these functions in the utriculus adds further weighty evidence in favour of the contention that, contrary to the classical theory[11], the utriculus may well be the only otolith organ concerned with the maintenance of equilibrium. Its fundamental sensory mechanism recalls that found in the semi-circular canals, in so far as the responses appear against a background of a steady basic discharge activity which can be modulated in opposite directions.

So far as I am aware, gravity responses to positional changes have only twice before been studied by the oscillographic method. Recording from filaments

selected at random from the cranial stumps of the anterior and posterior rami of the eighth nerve of the frog, Ross[3] described gravity responses from the anterior ramus which were presumed to be derived from the utriculus and generally reacted to one only of two opposite directions of tilting in the 'maximally stimulating' plane. The reaction obtained from the posterior ramus also included typical gravity responses, the accurate localization of which was, however, impossible.

Single-unit discharges from the vestibular nucleus of the brain-stem of the cat were recorded by Adrian[12], who was able to distinguish between gravity-controlled and rotation-controlled responses. The gravity receptors were increasingly stimulated during displacement from the normal. In the level position a low-frequency resting discharge was sometimes found which could be abolished by tilting in one direction and increased by tilting in the opposite direction. Response to lateral tilt and to fore-and-aft tilting was found to be separately localized in the vestibular nucleus, but Adrian points out in the discussion of his results that this does not necessarily imply their localization in two different otolith organs.

A discussion of these findings in comparison with the evidence reported in the present communication will be appended to the forthcoming full account of the work.

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POWER AND PERSONAL LEADERSHIP

THE Thomas W. Salmon Memorial Lectures, given in previous years by psychiatrists, were delivered at the New York Academy of Medicine last November by Prof. H. D. Lasswell, a social scientist known mainly for his studies of propaganda and his application of psychoanalytic concepts to problems of political science. His topic was "The Dynamics of Power and Personality". "The long-run aim of societies aspiring towards human freedom," said Prof. Lasswell, "is to get rid of power and to bring into existence a free-man's commonwealth in which coercion is neither threatened, applied nor desired. This is the thread of anarchist idealism that appears in all uncompromising applications of the key conception of human dignity." But the more accessible goal, to which Prof. Lasswell gave his main attention, is to secure a democracy in which power is shared as widely as possible and is subordinated to respect for the dignity of the human personality. He therefore discussed the types of people who in our society seek for power and provide leadership. He saw them as drawn very largely from the middle class, as a result not of economic accident but of the psychological characteristics of the class, in particular its tradition of sacrificing immediate gratifications to the acquisition of skills which will ultimately bring a larger reward. "We know that middle-class homes are hothouses of ambition, holding their children to high standards of achievement, and providing the tension between indulgence and deprivation so congenial to the accentuation of power [as a goal]." Within the middle class, professional families contribute a disproportionately large number of leaders, partly because their tradition of public service deters them from seeking purely private advantage in business life. Prof. Lasswell seemed to imply that political leaders' ideals of public service are largely rationalizations of narrower personal needs for power.

It was the less admirable types of power-holder to whom Prof. Lasswell gave most attention. He distinguished the compulsive (or obsessional) type, often bureaucratic in inclination; the dramatizing type, highly concerned with the emotional response he can elicit from others, and characteristically producing the agitator; and the detached type, whose own emotional response is largely screened from his consciousness, and who may supply "useful judges, arbitrators, conciliators, diplomatic negotiators and scientists", but in whom "the absence of lively emotional states can lead to calm, pitiless, destructive conduct". Apropos the obsessional bureaucrat, Prof. Lasswell developed the interesting suggestion that he harbours strong unconscious hostility to the authority of the system he is serving, and by excessive scruples and doubts in interpreting detailed rules he forces his superiors to take responsibility which they had intended to delegate, and so undermines the authority that he means most scrupulously to obey.

Prof. Lasswell pointed out that to understand the destructive form of power seen in war we must attend not only to war itself but also to manifestations of power found everywhere in our social structure; and he suggested that "concentrations of destructive impulse" occur as a result of competitive practices that we take for granted in commerce, industry and public life. "It is impossible to abolish acute destructiveness without altering the equilibrium of the entire social process, since such acute disturbances mainly give vent to stress that has accumulated through the social system as a whole." Hence he advocated a "social psychiatry", one function of which would be to study the tensions created by "the struggle to express native impulses in ways forbidden by authority", the sexual impulse providing one example. For the rest, his prescription against war was "Physical Defence, Psychological Offence", and he urged the opponents of Marxism to emulate the Marxists' effectiveness in political education and propaganda, especially in giving the public as clear a conception as possible of the goal of national policies.

THE FOURTH SOUTH AMERICAN CHEMICAL CONGRESS

THE Fourth South American Chemical Congress was held in Santiago, Chile, during March 1–7, with more than four hundred delegates attending from all the South American republics. Invitations to attend were also extended to a number of countries outside South America: Great Britain was represented by Prof. J. W. Cook, Prof. E. C. Dodds and Dr. F. N. Woodward, the United States of America by Dr. Alfred Gauger, Sweden by Prof. The Svedberg and Republican Spain by Dr. Francisco Giral.

At the inaugural session in the Law School of the University of Chile, where most of the sessions were held, the delegates and representatives were welcomed by Don Enrique Molina, the Minister for Education, and Don Juvenal Hernández, rector of the University; Dr. Felipe Justo, president of the Chemical Society of Argentina, replied on behalf of the delegates.

In his speech formally opening the Congress, Dr. Edouardo Cruz-Coke, professor of biochemistry in the University of Chile and president of the executive committee of the Congress, stated that this Congress was the largest yet held in South America and was planned to cover a wider field of chemistry than was possible at the Third Congress held at Rio de Janeiro in 1940. He indicated the executive committee's particular pleasure at the presence of so many representatives of non-South American countries, and later accepted on behalf of the committee a letter of greetings from the president of the Chemical Society brought from London by Prof. Cook and a copy of the fellows' register presented by Prof. Dodds on behalf of the Royal Society.

The Congress, which was particularly well organised, due largely to the efforts of Prof. Cruz-Coke, the two secretaries, Prof. Jorge Mardones and Prof. Hermann Schmidt-Hebbel, and their associates on the executive committee, was divided into thirteen sections. These covered the fields of physical and electro-chemistry, inorganic and geochemistry, organic chemistry, biochemistry, chemistry in relation to medicine and toxicology, nutritional chemistry, chemistry in relation to agriculture and applied botany, industrial inorganic and organic chemistry, metallurgy, fuels, chemical engineering and chemical education. During the course of the week, some four hundred papers were read, abstracts of which were made available to delegates in the form of a well-prepared 131-page printed booklet before the opening of the Congress. In addition to these, there were also eight 'Conferencia', two of which were given by British representatives. On March 3 Prof. Cook read a paper on "The Chemical and Biochemical Oxidation of the Aromatic Polynuclear Hydrocarbons", and on the following day Prof. Dodds lectured on "The Proteins as Biochemically Active Substances".

During the course of the week, the British representatives, who were very hospitably received, were given an opportunity of visiting many of the Chilean chemical and medical schools, museums and industrial organisations. The tour around the impressively equipped and staffed Hospital del Salvador was made in the company of Profs. Alessandri and De Amesti, who have been largely responsible for making this one of the most modern and efficient hospitals in South America, comparing favourably with the best European and North American hospitals.

The work of Profs. Edouardo Cruz-Coke and Hector Croxatto and their colleagues at the Medical Schools of the University of Chile and the Catholic University respectively on a wide variety of subjects, including the cardiac stimulants, the biochemistry of the hormones and vitamins, biological oxidations, organic iodo compounds, antibiotics, etc., was found to be both academic and developmental in outlook and conception. The science schools of the Chilean universities, unlike those in Britain and the United States, rely on outside sources for much of their income, and the teachers and students of these two schools consequently associate themselves closely with certain industrial organisations, and particularly with the Instituto Médico Técnico "Sanitas" S.A., a company producing a wide variety of organic chemicals including penicillin, organic arsenicals, D.D.T., and the more common pharmaceuticals. The Government-sponsored Instituto Bacteriologico operates in a similar field, and like Sanitas has modern and well-equipped factories and laboratories, and a well-informed and research-minded staff.

For the final sessions, the delegates were taken by road and special train to Valparaiso, where they were first entertained by the directors of the Nitrate Corporation at an impressive alfresco luncheon in the beautiful Parque de Salitre under conditions reminiscent, as one distinguished delegate observed, of Europe before the First World War. In the afternoon, the delegates were shown round the Santa Maria Technical University, where the formal closing session was held later.

The week's activities were rounded off at a colourful reception at the Vergara Palace, in the hills behind Vina del Mar, the beautiful and world-famous South Pacific health resort.

SCIENCE MASTERS' ASSOCIATION (SCOTTISH BRANCH)

THE first annual general meeting of the Scottish Branch of the Science Masters' Association took the form of a three-day meeting in the University of Glasgow during April 1–3, under the presidency of Sir Hector Hetherington, principal of the University. The meeting was attended by about 250 members of the Branch, and there were many visitors. The close and active co-operation of the staffs of the various departments of the University resulted in many exhibitions and demonstrations being available.

During the first day the Department of Chemistry staged exhibitions of the first-year practical course, new apparatus for esterification and distillation, fluorescence spectroscopy and photochemistry. Specimens of rare chemicals were also on view. The Department of Natural Philosophy had much to show in connexion with research in nuclear physics. Cloud-chamber experiments were demonstrated, a large magnet was seen in course of erection for cosmic ray studies, and various artificial radioactive isotopes were produced by neutron bombardment. Great interest was shown in the new 30-million volt synchrotron, under construction by Messrs. Metropolitan-Vickers, and the million-volt proton accelerator attracted many visitors. Prof. W. M. Smart, of the Department of Astronomy, arranged for the Observatory to be open for inspection during the afternoon, while in the Zoology Department the magnificent museum was open to members, and new biology films were shown. The Botany Department contributed a series of demonstrations in plant physiology, antibiotics (penicillin and streptomycin) and products manufactured from marine algæ. New methods of preserving biological specimens in transparent plastics were also shown.

The afternoon of the second day was set apart for visits to well-known Scottish firms specializing in the manufacture of special steels, coal-cutting machinery, nautical instruments, optical instruments, sulphuric acid and in shipbuilding.

One feature of the meeting was the exhibition of apparatus designed and constructed by members, and there was a special exhibit showing surplus apparatus available at very low prices to schools

through the Ministry of Supply and the Scottish Education Department. In cases where service apparatus could not be used in schools without adaptation, methods of doing this were demonstrated.

Mr. F. A. Meier, of the London Institute of Education, gave two lecture-demonstrations on the construction and use of scientific apparatus, and lectures were given by Prof. J. W. Cook, on "The Effects of Some Chemical Compounds on the Growth of Cells", by Prof. P. I. Dee, on "The Elementary Particles of Matter", and by Dr. H. F. Steedman, on "Practical Methods in Zoology".

At a discussion on "School and University Teaching", the chair was taken by Sir Hector Hetherington, and leading parts were taken by Prof. J. Walton, Prof. W. M. Smart and Mr. F. G. Daldy, of Trinity College, Glenalmond. Many other members of the Association joined in the discussion, and in response to suggestions put forward steps have been taken to promote a closer liaison between Scottish members of the Science Masters' Association and the faculties of science in the Scottish universities.

At the annual business meeting, Mr. H. S. Sowrey, Glasgow Academy, was elected chairman of the Branch in succession to Mr. W. J. Lodge, Fettes College. The joint secretaries are F. G. Daldy, Trinity College, Glenalmond, and J. Wallace, Melville College, Edinburgh, and the treasurer is W. P. D. Wightman, Edinburgh Academy.

A 150-TON UNIVERSAL STRUCTURE TESTING MACHINE

W. AND T. AVERY, LTD., of Birmingham have recently designed and built a 150-ton universal structure testing machine for Short Bros. and Harland, Ltd. (*Engineer*, December 26, pp. 594–596).

It is significant that it is no longer considered sufficient to carry out tests on the material from which a complicated structure is made, and to base design upon calculations made from the results of such tests alone. There is a growing need to apply as near full-scale tests as possible. Geometrical similarity in test-pieces tested under laboratory conditions show a dimensional effect which it is often difficult to explain, except by assuming an anisotropy or inhomogeneity of the material. It is still more difficult to predict the behaviour of a material under complicated stress distributions from the results of the standard mechanical tests carried out on carefully prepared samples of shapes designed to make the interpretation of the results as simple as possible.

The new Avery machine can accommodate specimens up to 9 ft. 9 in. long in tension and 15 ft. in compression, while it can also be adapted for carrying out transverse tests on specimens up to 7 ft. span.

The tension and compression units are separate. They are, in fact, two testing machines but having a common hydraulic oil pump for applying loads and a dynamometer and indicator cabinet which can be used with either. The advantages to be gained by the separate units are that the effective height is greater, so that longer specimens may be used; and although the two units cannot be used simultaneously, setting-up can proceed in one while testing goes on in the other. This is an important consideration when it is desired to attach the large number of strain gauges often required for the full interpretation of complicated sections or built-up structures. Against the separation of the testing units must be set one disadvantage, namely, the far greater space occupied by the whole machine.

The method of operation and load recording is similar to previous machines made by Avery's and to other machines of this type. There are four load-ranges: 0–150 tons in increments of 0·5 ton being the highest and 0–15 tons in increments of 0·05 ton the lowest. It is doubtful whether a machine of this capacity can, in fact, be used with any degree of accuracy on the lower range, and it would appear to be preferable to omit this range entirely and to use the machine for the purpose for which it was designed and for which it is eminently suitable.

C. F. TIPPER

GROWTH-PROMOTING SUBSTANCES IN HORTICULTURE

A CONCISE review by Dr. T. Swarbrick of recent developments in the application of growth-promoting substances in horticulture, with special reference to the researches carried out at Long Ashton since 1939, appears in Occasional Publications on Scientific Horticulture No. 5 (published by the Horticultural Education Association, c/o Gibbs and Sons, 16 Orange Street, Canterbury, Kent). Present applications include the acceleration of rooting in cuttings, the prevention of pre-harvest drop in apples and pears, the induction of parthenocarpic development in tomato and other plants, and finally their employment as selective weed killers.

Parthenocarpic fruits of apple and pear have been obtained with certain varieties but not with others, employing 2-4 dichloro-phenoxy-acetic acid, 2-6 dichloro-phenoxy-acetic acid and also beta-naphthoxy-acetic acid. In all cases, however, the artificially 'set' fruit grew slowly and never attained normal size. Similar development was induced in Miller's seedling apple and Conference pear following frost damage to the 'set' fruit during the spring of 1945. Beta-naphthoxy-acetic acid has also proved effective in inducing a very marked increase in 'set' and yield of the self-sterile varieties of strawberry, Tardive de Leopold and Oberschlesien.

Two interesting lines of investigation are suggested by the fact that crude extracts of the flowers have been found to induce parthenocarpic development in tomato, and secondly, that stilbœstrol, a synthetic œstrogen of high potency in animals, is similarly effective. Certain of these growth substances, when used at concentrations higher than that required to induce parthenocarpy, produce modification of leaf shape and venation and clearing of the veins closely simulating many characteristic symptoms of virus infection. This raises interesting conjectures concerning the nature of the action of virus on host. The effect of tri-iodo-benzoic acid in modifying lateral and terminal vegetative shoots of tomato to form flower trusses constitutes an interesting parallel to the suspected action of naturally occurring hormones which are believed to initiate the formation of flower primordia.

The progress already achieved in this field suggests that a joint attack by biochemist and plant physiologist may be expected to lead to a rapid expansion in our knowledge of the biochemical control of development and reproduction in plants.

FORAGE RESOURCES OF LATIN AMERICA

BULLETIN 37 of the Imperial Bureau of Pasture and Forage Crops, Aberystwyth, has been prepared by Hugo W. Alberts, in association with the Technical Collaboration Branch, Office of Foreign Agricultural Relations, United States Department of Agriculture. It has been issued by the Imperial Agricultural Bureaux (Pp. 24. 2*s*. 6*d*.).

Grazing and browsing, as it is best known to the forester, of domestic or semi-domestic animals has become an increasingly intensified problem in the modern world. The present monograph gives information in some detail on the position in Peru and their forage resources. The author divides the country roughly into three geographic regions, the coastal region, the sierra and the oriente or montana. The latter, situated to the east of the Andes, consists mainly of tropical forest, the grazing and pasture question having little importance. Since remote times, the Andean Indians of Peru have grazed llamas and alpacas, native to the grasslands of the sierra. These animals had been domesticated and raised for their meat and hides by the time the Spaniards arrived. The llamas were used also as pack animals. On account of the nature of the grasses in many of the mountain valleys, there was always some grazing even in the driest times, because there were two general types of forage, consisting of short grasses, fairly high in palatability, and tall grasses, of lower food value. The tall grasses were not eaten during the rainy season when there was plenty of the short grass available, and consequently the former formed a reserve for the winter months and periods of drought.

Along the coast, forage is produced chiefly to feed dairy cattle. In the sierra, native range grasses supply forage for sheep, llamas, alpacas and some beef and dairy animals. The kinds of forage grown along the coast are principally alfalfa and para grass, supplemented by maize, which is cut and fed in the green state. The native range lands of the sierra produce various species of grasses, which may be classified into two general groups, namely, tall grasses and short grasses, already alluded to. Tropical rain forest species of grasses comprise the principal forage in the oriente.

Some of the pasture lands in different regions are irrigated. The number of animals which can be grazed on areas of from two to three hectares varies considerably, and probably requires a further close study.

EARTHQUAKES DURING JULY–AUGUST, 1947

TWELVE large earthquakes and a score of smaller ones were recorded by the world's seismographs during July, and nine large shocks with numerous smaller ones during August. Provisional epicentres for the large earthquakes have been determined by the U.S. Coast and Geodetic Survey in co-operation with Science Service and the Jesuit Seismological Association.

The largest earthquakes of the two-monthly period were those of July 29 and August 5. That of July 29 occurred on the borders of Tibet and Burma, and was recorded in America, New Zealand and Europe. At Kew the resulting ground amplitude reached 290 μ at maximum. The earthquake of August 5 had its epicentre about lat. 25° N., long. 62° E. in the Arabian Sea south of Baluchistan. It was registered in America and Europe, where the ground amplitude reached 250 μ at Stuttgart. It is not yet known whether the Tibet earthquake did any serious damage or not.

Deep-focus earthquakes occurred on July 13 east of the Fiji Islands (100 km. deep), on July 25 in the northern Argentine (400 km. deep) and on September 2 west of the Tonga Islands (200 km. deep). These demonstrate that the viscosity of the material in the earth was large at these depths, places and times, thus giving a clue to earth structure.

Two unusual epicentres are placed in North America; one on July 10 in Baffin Bay, recorded at American stations and Stuttgart, and the other on August 10 at lat. 41·9° N., long. 84·5° W., in southern Michigan, recorded in North America but not in Europe.

Also during the period movement was going on in mid-Atlantic, where an earthquake occurred at lat. 54° S., long. 30° W. near South Georgia on July 23, and one on August 9 at lat. 1° N., long. 28° W., the latter known to be a seismic area. On July 15 repeated earthquake shocks brought down the dome of the church of San Felipe at Pasto, Colombia, and destroyed the high altar. Houses also collapsed and serious damage was done to the University and to the airport. Four people were seriously injured, and the tremors may have been associated with the eruption of a volcano near the city. This shock may have been the one which was registered at De Bilt, Belgrade and Stuttgart near 14h. 30m. G.M.T.

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, April 26

INSTITUTION OF ELECTRICAL ENGINEERS (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Discussion on "Industrial Applications of Photo-electric Cells" (to be opened by Mr. F. Baxendale).

ROYAL GEOGRAPHICAL SOCIETY (at Kensington Gore, London, S.W.7), at 5.30 p.m.—Dr. Edward Lynam: "English Surveyors and Mapmakers, 1555–1611".

INSTITUTION OF THE RUBBER INDUSTRY, MANCHESTER SECTION (at the Engineers' Club, Albert Square, Manchester), at 6.15 p.m.—Annual General Meeting.

Tuesday, April 27

BRITISH SOCIETY FOR INTERNATIONAL BIBLIOGRAPHY (at the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, W.C.2), at 2.30 p.m.—Papers.

UNIVERSITY COLLEGE, LONDON (in the Physiology Theatre, Gower Street, London, W.C.1), at 5 p.m.—Dr. D. B. Fry: "Speech". (Further lectures on May 4 and 11.)*

ROYAL STATISTICAL SOCIETY (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 5.15 p.m.—Dr. J. Wishart: "The Teaching of Statistics".

INSTITUTION OF CIVIL ENGINEERS (at Great George Street, London, S.W.1), at 5.30 p.m.—James Forrest Lecture.

MANCHESTER GEOGRAPHICAL SOCIETY (in the Geographical Hall, St. Mary's Parsonage, Manchester), at 6.30 p.m.—Dr. Mary Clarke: "Impressions of a Visit to China".

SOCIETY OF INSTRUMENT TECHNOLOGY (at the Royal Society of Tropical Medicine and Hygiene, Manson House, 26 Portland Place, London, W.1), at 6.30 p.m.—Mr. A. J. Young: "Some Impressions of Modern American Instrumentation".

Tuesday, April 27—Friday, April 30

INSTITUTE OF WELDING (at Manchester).—Annual Spring Meeting.

Wednesday, April 28

PHYSICAL SOCIETY, COLOUR GROUP (at the Royal Photographic Society, 16 Prince's Gate, London, S.W.7), at 3.30 p.m.—Dr. R. K. Schofield: "The Report on Colour Terminology"; Discussion on "The Correlation of Colour Terms used in Physics, Industry and Ordinary Speech".

ROYAL MICROSCOPICAL SOCIETY, SECTION OF INDUSTRIAL MICROSCOPY (in the Hastings Hall, B.M.A. House, Tavistock Square, London, W.C.1), at 6 p.m.—Dr. F. Smithson: "Microscopy of Ceramic and Raw Materials".

SOCIETY OF CHEMICAL INDUSTRY, FOOD GROUP (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6.30 p.m.—Seventeenth Annual General Meeting: Dr. E. B. Hughes: "On the Chemistry of Coffee".

Thursday, April 29

BRITISH GLACIOLOGICAL SOCIETY (joint meeting with the BRITISH RHEOLOGISTS' CLUB and the INSTITUTE OF METALS, at 4 Grosvenor Gardens, London, S.W.1), at 3.45 p.m.—Film illustrating the Methods of Glacier Research in the Field used by the Jungfraujoch Glaciological Research Party, 1938: at 5 p.m.—Discussion on "The Flow of Ice and of other Solids" (to be opened by Dr. E. Orowan, F.R.S., and Dr. M. F. Perutz).*

ROYAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Scientific Papers.

LINNEAN SOCIETY OF LONDON (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Prof. D. M. S. Watson, F.R.S.: "The Mechanism of Evolution" (Hooker Lecture).

INSTITUTION OF ELECTRICAL ENGINEERS (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Mr. R. B. Giles: "The Economical Utilization of Electricity in Great Britain".

ROYAL STATISTICAL SOCIETY, SHEFFIELD GROUP of the INDUSTRIAL APPLICATIONS SECTION (at the Royal Victoria Hotel, Sheffield), at 6.30 p.m.—Mr. R. A. Nowlan: "Statistical Methods Applied to the Inspection and Testing of Aeronautical Materials".

ROYAL INSTITUTE OF CHEMISTRY, MANCHESTER AND DISTRICT SECTION (at the Engineers' Club, Albert Square, Manchester), at 7 p.m.—Annual General Meeting; Mr. J. R. Whinfield: "Terylene".

ROYAL PHOTOGRAPHIC SOCIETY, SCIENTIFIC AND TECHNICAL GROUP (at 16 Prince's Gate, London, S.W.7), at 7 p.m.—Mr. G. A. Jones: "Tone Control with Unsharp Masks".

Friday, April 30

PHYSICAL SOCIETY, OPTICAL GROUP (in the Physics Department, Imperial College of Science, Imperial Institute Road, London, S.W.7), at 3 p.m.—Seventh Annual General Meeting; at 3.15 p.m.—Prof. S. Tolansky: "Some Further Applications of Multiple-Beam Interferometry".

BRITISH INSTITUTION OF RADIO ENGINEERS, MIDLAND SECTION (at the Technical College, The Butts, Coventry), at 6.30 p.m.—Mr. J. Moir: "The Acoustic Aspects of High Quality Reproduction".

INSTITUTE OF PHYSICS, MANCHESTER AND DISTRICT BRANCH (in the New Physics Theatre, The University, Manchester), at 6.30 p.m.—Annual General Meeting; at 7 p.m.—Dr. D. Shoenberg: "Superconductivity".

INSTITUTION OF ELECTRONICS, NORTH-WESTERN BRANCH (in the Reynolds Hall, College of Technology, Manchester), at 6.30 p.m.—Mr. D. M. Corke: "The Application of Electronics to Vibration Research".

MANCHESTER STATISTICAL SOCIETY, INDUSTRIAL GROUP (at the Society of Architects, 16 St. Mary's Parsonage, Manchester), at 6.45 p.m.—Mr. E. C. Fieller: "The Mathematics Division of the National Physical Laboratory, with special reference to Statistical Methods".

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 9 p.m.—Sir Harold Spencer Jones, F.R.S.: "The Age of the Universe".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

BIOLOGIST, with B.Sc. in Zoology or Biology, and a CHEMIST, with B.Sc., preferably in Biochemistry—The Clerk, Birmingham Tame and Rea District Drainage Board, 117 Colmore Row, Birmingham 3 (April 30).

ENGINEERING SCIENTIST to the research department of a group of Companies in the North-West manufacturing a large range of textile machinery—The Ministry of Labour and National Service, Technical and Scientific Register, K Section, York House, Kingsway, London, W.C.2, quoting A.43/48A. (April 30).

LECTURER IN AGRICULTURE (Grassland Husbandry)—The Registrar, Wye College, Wye, Kent (April 30).

UNIVERSITY LECTURER IN GEOGRAPHY—The Secretary, Appointments Committee of the Faculty of Geography and Geology, Department of Geography, Downing Place, Cambridge (May 1).

GRADUATE ASSISTANT IN THE DEPARTMENT OF BIOCHEMISTRY—The Administrator, Radcliffe Infirmary, Oxford (May 1).

READERSHIP IN ENTOMOLOGY at the London School of Hygiene and Tropical Medicine—The Academic Registrar, University of London, Senate House, London, W.C.1 (May 3).

ASSISTANT HORTICULTURIST in the Department of Agriculture, Southern Rhodesia—The Secretary, Office of the High Commissioner for Southern Rhodesia, 429 Strand, London, W.C.2 (May 5).

ASSISTANT LECTURER or a LECTURER IN GEOLOGY, a LECTURER IN PURE MATHEMATICS, ASSISTANT LECTURERS IN APPLIED MATHEMATICS AND BOTANY, an ASSISTANT LECTURER IN GEOGRAPHY, and a DEMONSTRATOR IN PHYSICS—The Registrar, University College, Singleton Park, Swansea (May 8).

ASSISTANT LECTURER or LECTURER IN THE DEPARTMENT OF GEOGRAPHY, an ASSISTANT LECTURER or LECTURER IN THE DEPARTMENT OF PHYSICS, and an ASSISTANT LECTURER IN ECONOMIC STATISTICS—The Registrar, The University, Leeds 2 (May 8).

ASSISTANT LECTURER IN MATHEMATICS, and a LECTURER or ASSISTANT LECTURER IN GEOLOGY—The Registrar, King's College, Strand, London, W.C.2 (May 8).

LECTURERS (3) and an ASSISTANT LECTURER IN NATURAL PHILOSOPHY, and a LECTURER IN MATHEMATICS—The Secretary, The University, Aberdeen (May 10).

SENIOR ENTOMOLOGIST in a survey team investigating pest infestation in Nigeria—The Under-Secretary of State, Research Department, Colonial Office, Palace Chambers, Bridge Street, London, S.W.1 (May 10).

DEMONSTRATOR IN THE DEPARTMENT OF CHEMISTRY—The Secretary, Bedford College for Women, Regent's Park, London, N.W.1 (May 14).

ASSISTANT LECTURER IN GEOLOGY—The Registrar, University College, Southampton (May 15).

LECTURER IN EXPERIMENTAL PHYSICS—The Secretary, Queen's University, Belfast (May 15).

LECTURER or ASSISTANT LECTURER IN THE DEPARTMENT OF GEOGRAPHY—The Secretary, Bedford College for Women, Regent's Park, London, N.W.1 (May 21).

PRINCIPAL RESEARCH OFFICER or SENIOR RESEARCH OFFICER (Plant Physiologist), Division of Plant Industry, Canberra, Australia—The Secretary, Australian Scientific Research Liaison Office, Australia House, Strand, London, W.C.2, quoting No. 1642 (May 22).

ASSISTANT EXPERIMENTAL OFFICERS in Scientific Establishments in various Government Departments—The Secretary, Civil Service Commission, Scientific Branch, 27 Grosvenor Square, London, W.1, quoting No. 2162 (May 27).

PROFESSOR OF METALLURGY at King's College, Newcastle-upon-Tyne—The Registrar, University Office, 46 North Bailey, Durham (May 28).

LECTURER (Grade II) IN THE DEPARTMENT OF CHEMISTRY (with special qualifications in organic chemistry)—The Registrar, Queen Mary College, Mile End Road, London, E.1 (May 31).

HEAD OF THE DEPARTMENT OF SOCIAL AND ECONOMIC RESEARCH, University College of the West Indies—The Under-Secretary of State, Research Department, Colonial Office, Palace Chambers, Bridge Street, London, S.W.1 (May 31).

LECTURER and an ASSISTANT LECTURER IN STATISTICS—The Registrar, Trinity College, Dublin (June 15).

SCIENTIFIC ASSISTANT for miscellaneous duties connected with a scientific information service and an abstracting journal—The Director, Commonwealth Bureau of Dairy Science, Shinfield, Reading, Berks.

ASSISTANT CURATOR—The Curator of the Museum, Institute of Jamaica, Kingston, Jamaica, B.W.I.

LABORATORY TECHNICIAN (Grade B), and a JUNIOR STUDENT LABORATORY TECHNICIAN (Grade C), IN THE DEPARTMENT OF MORBID ANATOMY—The House Governor, St. Mary's Hospital, Paddington, London, W.2.

LECTURER IN PEDOLOGY—The Registrar, Wye College, Wye, Kent.

INORGANIC CHEMIST for research—The Director, Tin Research Institute, Fraser Road, Greenford, Middlesex.

LECTURER IN THE PHYSICS DEPARTMENT—The Secretary, Northampton Polytechnic, St. John Street, London, E.C.1.

LABORATORY TECHNICIAN—The Director, British Welding Research Association, 29 Park Crescent, London, W.1.

SCIENTIFIC ASSISTANT (university graduate in science or agriculture)—The Director, Commonwealth Bureau of Animal Nutrition, Rowett Research Institute, Bucksburn, Aberdeenshire.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

British Science News. Vol. 1, No. 1. Special Number: Centenary of the Chemical Society of London. Pp. 16. (London: British Council, 1947.) 6d. [128

Heredity: an International Journal of Genetics. Published 3 times a year. Vol. 1, Part 1, July. Pp. 141. (London and Edinburgh: Oliver and Boyd, 1947.) 14s., 3 dollars; 40s., 8.50 dollars annual subscription. [128

Human Relations: a Quarterly Journal of Studies towards the Integration of the Social Sciences. Vol. 1, No. 1, June. Pp. 140. (London: Tavistock Institute of Human Relations; Cambridge, Mass.: Research Center for Group Dynamics, Massachusetts Institute of Technology, 1947.) 10s.; 35s. annual subscription. [138

Other Countries

Ministry of Public Works, Egypt. Physical Department Paper No. 47: The Nile Basin. By Dr. H. E. Hurst and R. P. Black. Third Supplement to Vol. 3: Ten-day Mean and Monthly Mean Gauge Readings of the Nile and its Tributaries for the Years 1938–1942 and Normals for the Period 1912–1942. Pp. 389. (Cairo: Government Press, 1946.) 50 P.T.; 10s. [128

Carnegie Institution of Washington. Publication 569: Studies on Carbohydrate and Fat Metabolism, with Especial Reference to the Pigeon. By Oscar Riddle and associates. Pp. v + 128. (Washington, D.C.: Carnegie Institution, 1947.) 1.85 dollars. [128

Annals of the New York Academy of Sciences. Vol. 48, Art. 7: Some Aspects of Red Cell Production and Destruction. By Eric Ponder, William B. Castle, Harry A. Charipper, William Dameshek, Albert S. Gordon, S. Granick and F. S. Robscheit-Robbins. Pp. 577–704. (New York: New York Academy of Sciences, 1947.) 2 dollars. [138

German Hydrographic Institute, Hamburg. Authorized by Allied Control Council, Germany. Annual Report No. 1, 1946. Pp. 64. (Hamburg: German Hydrographic Institute, 1947.) [138

South African Science. Vol. 1, No. 1, August. Pp. 32. (Johannesburg: South African Association for the Advancement of Science, 1947.) 1s. 6d.; 15s. per annum. [196

Dialectica: International Review of Philosophy of Knowledge. Vol. 1, No. 1, February 15. Pp. 112. Vol. 1, No. 2, May 15. Pp. 113–240. (Neuchatel: Editions du Griffon; Paris: Presses universitaires de France, 1947.) 4.80 francs each; subscription, 18 francs. [218